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LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE

MINUTES

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Global Climate Change Commission Meeting
Thursday, 22 February 2007
2:15 p.m.
Room 643 LOB

The Legislative Commission on Global Climate Change met on Thursday 22nd February in Room 643 of the Legislative Office Building with Representative Joe Hackney, Co-Chair, presiding. Other members present were: Sen. Cowell, Rep. Harrison, Rep. Underhill, Rep. Wilkins, Mr. Clark, Dr. Eggers, Dr. Erickson, Mr. Tim Toben, Mr. Ivan Urlaub, Ms. Tompkins, Dr. Crawford-Brown, Mr. Everett, Mr. Howard, Mr. Profeta, Dr. Boyles, Dr. Riggs, Mr. Shore, Mr. Slocum, Dr. Smith, Mr. Stephenson, Dr. Uzochukwu, and Mr. Ebert. The visitor registration is Exhibit A.

Representative Hackney called the meeting to order and indicated that Co-Chair, Mr. Garrou is on his way back from Australia and gave the floor to Mr. Givens for introductory remarks.

Mr. Givens stated that each member should have six documents in front of them including an agenda and called attention to agenda item 5 which is an Introduction of visiting Members of the British House of Commons in London (Michael Ancram, Q.C.M.P.; Charles Hendry, M.P.; Peter Kilfoyle, M.P.; and Bill Olner, M.P.) They will be here around three and we will be briefed on what they have to say.

Each member should have a memo (Exhibit B), an agenda (Exhibit C), Interim Report to the Environmental Review Commission and the General Assembly of North Carolina (Exhibit D); Climate Action Plan Advisory Group Memo (Exhibit E); Protecting our Coastal Economy ASBPA by Dr. Erickson (Exhibit F); and a document from the John Locke Foundation from Senator Pittenger (Exhibit G).

Representative Hackney noted the presence of Secretary Ross in the audience and asked if the secretary would like to say a word of welcome to the group.

In accordance with our agenda we will proceed to consideration of recommendations for inclusion of the interim report and recognize Brock Nicholson, Deputy Director, Division of Air Quality.

Brock Nicholson: Mr. Nicholson thanked the chairman and stated as indicated at the last Commission meeting on the 12th of January we did have our CAPAG meeting on January 24th in which we considered those mitigation options that we thought were to be early consensus items. We did get early consensus on a number of them. We focused on options where we had early cost and benefit analyses – that early analyses was complete at least in a draft form and it was

based on a unanimous consensus of the CAPAG group which I think is important. We wanted to have it as a fairly tight filter at this stage of the game so that what you see before the Commission today was in fact a unanimous consensus of the CAPAG members. That was 16 of the 53 mitigation options for which we have identified out of the 300 or so that we want to focus our analyses on. We did have a majority of the CAPAG members present at this meeting and felt like it was a good balance and a strong signal in terms of this consensus. We did have further discussion and consideration of other options and it did result in the identification of the need for additional analyses requirements. I will note that all of the cross cutting items were voted unanimously to come forward to this meeting as recommendations to this body. The next question is what is the process of the CAPAG going forward from here? Certainly, on the remaining 37 options we are going to have further analyses, further discussion, in both the CAPAG itself, but first in the technical work groups and work through all of those issues that any of the members may have had on these additional items and refine that and adjust those items until we do reach a form of consensus. Not necessarily a unanimous consensus for the remainder of the process but we are looking for a consensus. We will share this progress with the Commission as we are going along. The schedule basically is that we will have the next CAPAG meeting on May 8th of this year and that will be the sixth meeting, the seventh meeting will be on July 16th and then we may as an optional meeting, have one in the September/October time frame. A draft report by September 07 is what we are shooting for with the final reconciled inventory and projection report for greenhouse gases in November 2007 and then the final report of the CAPAG by December 2007. All of this is hinged on a contract extension we are working on with the Center for Climate Strategies and Tom Peterson.

After December 07 we anticipate that some number of us, whether it's with the department or CAPAG itself, will be involved in presentations, etc. both to the Legislative Commission as well as the administration or the Legislature otherwise and certainly to the public. Lastly I want to thank those Commission members that have been active participants in the CAPAG process. It has been a very important aspect of what we have been doing. At this time I would like to turn it over to Tom to get into the meat and details and the numbers and so forth in our interim report.

Representative Hackney: Brock, thank you for all the work that's gone into the CAPAG process and we look forward to moving through these items. Mr. Peterson.

Mr. Tom Peterson: Thank you. I have a recommendation memo with the 16 items that the CAPAG recommended as early consensus.

Representative Hackney: This is the packet that you all should have that has the letterhead of Center for Climate Strategies is that correct? Does everyone have a copy of that before them?

Mr. Peterson: That is correct. Let me ask in terms of your preference for proceeding here. We have a list of the sixteen that are broken in three batches, if you would like us to walk through those either in brief or detail we can do so or if you have another preference by all means let me know how you would like to proceed.

Representative Hackney: Let's plan to run through them twice, once for you to make an explanation and then we can see them all before we start voting on them. That way you know what is ahead before you vote on the first ones.

Mr. Peterson: In order to do that what I would like to do is quickly do a phone link with our lead consultant for the first batch of these things Brent if you could get him on the horn. What we will be doing with the document in front of you should be relatively straightforward. Beginning on page 1 of the document you will see the first batch of actions these are known as residential, commercial and industrial. This is where we see energy use and process related emissions in what is typically referred to as the stationary source sector otherwise known as buildings, facilities, manufacturing, and institutions but this is essentially an energy efficiency and conservation package and that has a number of items involved that are labeled by the number that has been assigned to them in the CAPAG process. We have 53 options and we assigned a label and number to each and so you will see RCI2 right through RCI11 and these are the CAPAG assigned numbers for these options that we will refer to from here forward when we go through the list. The second batch is what we call energy supply on page 2 – we have two options there. This is a set of actions that relate to the generation of heat and power in North Carolina and electricity and direct fuel use for the stationary source sector. Just as a point of clarification, liquid fuels for mobile sources are not included they would be included in the transportation and land view section. The third batch that we will go through lies by the name of cross cutting issues functionally. This includes reporting registries, education, goals, adaptation a set of things that are not unique to a particular sector and as consequences are called cross cutting. There are six options there. So what I would propose to do is very briefly walk through each batch and each option and then depending on need we can have clarifying questions. Our lead consultant for RCI will be on the phone to help us with that. Just so you know, Randy Strait has been one of our lead consultants on the cross cutting issues, also David VonHeckle who is joining us on the phone has been principally involved in the energy supply issues that we will be touching on in just a moment.

Representative Hackney: All right let's proceed.

Mr. David VonHeckle: Good morning members of the Commission.

Mr. Peterson: David what we will do here will be our usual federal express version and then we'll be circling back for clarifying questions later. So if you

could do the federal express on RCI.

Mr. VonHeckle: Ok I'll provide approximately two sentence description on each of these RCI options. These are the options that did receive consensus at the last CAPAG meeting. RCI2 is expanded energy efficiency funds this is an expansion of the collection of funds to approximately the level of one percent of utility revenues in both the electricity and natural gas sectors and those funds would be spent on energy efficiency programs in each of the residential/commercial/industrial sectors. They would be spent on a variety of different applications and we haven't and probably will not specify those precisely but basically a range of different energy efficiency options.

RCI3 is energy efficiency requirements for government buildings and these are for state and local and municipal government building that would be above and beyond building code requirements including some of the expanded building requirements for energy efficiency that are included in other RCI options. We would essentially breach code, if you will, for government buildings to target.

RCI4 is market transformation and development programs. These are opportunities for the combination of groups including public groups, private groups, retailers, manufacturers of energy efficient equipment and appliances to come together to offer opportunities to transform market so that the markets themselves pick up more efficient appliances and equipment without the application of additional codes. This actually goes beyond what is in RCI5 which is improved appliance and equipment efficiency standards. Here there is consideration of a standard that goes beyond the federal level. But there is substantial preference on the part of the CAPAG and as well as in our technical work group to make sure that if standards for appliances and equipment go beyond federal standards are on equipment that are not covered by federal standards that there will be as much coordination as possible with other states also considering these higher standards so that it is not just a North Carolina statistic standard. But a standard that covers a number of different states, preferably in the regions but perhaps in other areas of the nation as well. This option also includes a recommendation that North Carolina support higher standards at the federal level because that is the most efficient in terms of application by manufacturers of higher standards nationwide.

RCI6 is an improvement in building energy codes which includes a combination of improved energy efficiency standards, higher energy efficiency standards for North Carolina buildings and also an enhancement to make sure that the building codes are well supported by inspectors and by building designers, building developers so that it includes as an implementation mechanism as a bunch of implementation mechanisms educational mechanisms to make sure that these building codes can be applied well in North Carolina.

RCI7 is beyond code building design incentives and targets including incorporating local building materials and advance construction. This option is sort of an inaudible to the breech code or the beyond code activities included in RCI3 for government buildings except this is for private and non-government buildings. It's essentially intended to be incentives and other supporting types of mechanisms to get buildings to be much more efficient than they are today. In fact more efficient than the enhanced building codes would have them be. They are working toward a situation where there is much less, perhaps even fifty percent less energy consumed on average in buildings per unit of floor area than there is now.

RCI8 is a combination of education measures including education for consumers for primary and secondary school students and post secondary and specialist education taking place in colleges and universities and other venues. In support of the overall goal of reducing greenhouse gas emission in the State of North Carolina and also in support of the specific element of the different residential, commercial, industrial and in many cases other technical working groups suggestions. So this option does not include, we have not done any quantification for this option because many of these elements are very important to, but almost integral to some of the other options, but cannot easily be described savings or cost on their own.

RCI11 is the last of the options that received consensus at the CAPAG meeting although there are several RCI options still pending. RCI11 is residential, commercial, and industrial energy and emissions technical assistance. What is often been called audits in the past and recommended measure implementations. So its support for our process where experts sometimes engineers, sometimes well trained technicians would go into residential, commercial, industrial buildings and make suggestions at the opportunities for energy savings and in the cases of some industries, opportunities for reducing non-energy related process emissions for greenhouse gases. That's the RCI package that is before you right now.

Mr. Peterson: And before we proceed to the next batch let me just amplify a little bit. If you will turn to page 4 of that same memo you will see a table that summarizes the options that David has just reviewed and that table includes quantification of estimated potential greenhouse gas reductions as well as the potential cost or cost savings associated with the implementation of those measures. The numbers under the first three columns are expressed in million metric tons carbon dioxide equivalent reduction. The $ columns, just so you know, if you see a negative sign there, that means that the cost savings measure as opposed to a cost spending measure on the net. The analysis of these resolved on specifications of the work groups, David can elaborate if necessary on that. In addition to the table summary on page 4 you will find for each of the options that David has just reviewed on the following pages from 5 – 13 a one page description of that option which includes a mitigation option description,

what we call option design which specifies the goals, timing and participating parties involved in that. Those are key mitigation option design parameters that we use for actually analyzing reductions and cost. And finally potential implementation mechanisms, these are the specific approaches by which this action might be implemented and that includes potentially the implementing agents or agencies. You will note as you review these, that in some cases the CAPAG was prescriptive in terms of how these options might be implemented and in other cases they were not prescriptive assuming that additional details would need to be worked out later through either rule making or what ever sort of follow up implementation process might be appropriate. Would you like me to go through the entire list before we circle back?

Representative Hackney: I think maybe we ought to take them section by section – so let's go back through this section. Do we still have David on the phone? Let's take discussion and see if there are any motions on these starting with RCI2 on page 5.

Representative Harrison: I need a little bit more of an explanation about the net present value and cost effectiveness. All of these are negative numbers so they are all cost savings. I guess I'm trying to figure out what exactly they mean. You've got the carbon emissions reduction achieved in that one column and then you've got this net present value, I don't think I really know what that means with cost effectiveness.

Mr. Peterson: My apologies for too many acronyms and such just to go to Table 4 and let me know if I don't answer your questions. But the very first column which we've got instead of the three columns that are underneath the heading GHG reductions, that's greenhouse gas reductions milimetric tons. And we have a snap shot for any particular option. What we did is we quantified the amount of greenhouse gases that would be estimated to be removed from the atmosphere over a given period of time. That time period is specified in the longer write-ups of these options under goals and timing – when it starts, when it stops. The typical start up is present and runs through the year 2020. What we do is we analyze the cumulative greenhouse gas reductions that occur between the start and end point for that option and that is that number that's under the column that says total 2007-2020. That's the total reduction over that period. We provide snap shots for years 2010 and 2020 that are annual snap shots of reductions during that same period; so that's on the reduction estimates, how we arrive at those numbers. On the economic numbers we do something similar – we look at the combination of positive and negative costs of implementation between the start and end periods of the option and that is the column that is net present value 2007 through 2020. That is the sum total of the net position of the positive and negative cost over that time period that is financially discounted to adjust for the time value of money. I think our discount rate is either five or seven percent and we use whatever the standard state discount rate is for impact analyses. The next column which is cost effectiveness is the average net cost per ton

which in this case the negative means a cost savings of removing emissions from the atmosphere during that period of present through 2020 whatever the start and end periods of that option are. So throughout the duration of the implementation of that that would be the average cost effectiveness in discounted terms of removing emissions. The negative numbers again indicate that cost savings, David could split out the details in most cases, that is a number that represents expenditures for energy – so it is an energy savings number that has been modified.

Representative Harrison: Thank you. So we've got a classifiable figure for the carbon reductions.

Mr. Peterson: Yes.

Representative Hackney: Further discussion on RCI2? Dr. Everett, what took you so long?

Dr. Everett: I was waiting for others to speak. For those of you who are not part of these working groups and haven't had the benefit of all the hours of time that we've spent in these figures, you're now just as confused as we are and I asked the very same question Representative Harrison asked. It appears that if you look at these tables and maybe it's because I am just not capable of understanding it. But you have to ask yourself what in the world have we been doing? We could be saving millions of dollars if we had been doing all of these things. So there clearly is some cost here that does not get very well captured and I don't know how best to capture it. But we somehow have to say to the people that look at these tables, for example, maybe we should just look at the expanded energy efficiency fund, that the funds have to come from somewhere and that is the piece that seems to get lost over. It appears that we should just go out tomorrow and save all this money and that's the translation that is very difficult for me to make. And I think for the people who were in the working groups we continued at each of these meetings to get these same packets that we had a difficult time digesting and understanding. So I would just say there is a translation problem for me and maybe it's just me but otherwise we have lots of opportunities here and it's free.

Representative Hackney: What is the amount of the public benefits charged currently?

Mr. Nicholson: I understand but I certainly could stand corrected, I believe it is five percent of a dollar or 1/20th of what is being proposed here.

Mr. VonHeckle: That sounds correct to me approximately.

Representative Hackney: Further discussion?

Ms. Choi: I also like George have been participating in the CAPAG process and Tom I don't know if you recall the conversation that we had on the 24th. But this particular RCI2 was also a recommendation that was in another working group and we sent that one back for further study and when we discussed this. Then we thought that this also would be going back because it was the same recommendation coming out of two working groups equivalent to the energy supply, seven which we sent back for further study and particularly to address some of the questions that came up around what is the cost to the customer in that impact and the confusion over some of the figures.

Mr. VonHeckle: I think I heard much of that. Let me just step back a second and explain where this negative net present value number comes from. Both Mr. Everett and the person who just spoke are perfectly correct that there are costs to saving this energy. So you're seeing a negative 1.3 billion dollars in net present value, well that is a net figure – so there are costs to purchase more efficient equipment than would have been purchased otherwise. For example, a higher efficiency refrigerator or a more efficient motor than a customer would have purchased otherwise. There are also costs for administration of management program for example which might be done by a utility, might be done by another party, those costs are all in there, but they are more than offset by the savings in what we call avoided costs. Avoided costs of electricity, avoided costs of natural gas and in preparing this estimate what we have used on the electricity savings side have been avoided costs that have been derived from documents submitted to the North Carolina Utilities Commission by the major utilities. So it ends up at about 5.6 cents per kilowatt hour and that includes some credit for both energy that is the fuels that goes into electricity generation as well as capacity, so that's on the savings side. That is the negative part of it then there is a positive part of it which is the costs of saving energy. The cost of applying energy efficiency measures again and that is both including the administrative cost in the program and the net cost to everybody who contributes to that cost which is going to be both the utility or the program sponsor and the customer. The combination of those costs we've used a value that is about 3.3 cents per kilowatt hour saved lifetime by the options that are included in these energy efficiency funds. And that number came from a study done and completed at the end of 2006 by a firm called GDS done for the North Carolina Utilities Commission and we just updated our analyses to include that particular number – that is an average of all of the options that were included as cost effective options by GDS. And their cost effectiveness standard was actually five cents per kilowatt hour.

Representative Hackney: Thank you David.

Mr. Peterson. Thank you David I think we are going to summarize and move on. Just for clarification I think I would like for folks to know that in your decision memo on page 3 we have a listing of links for ...

Representative Hackney: Mr. Peterson we don't need to do that let's continue discussing on this item. Mr. Smith.

Dr. Smith: Thank you Mr. Chair. I guess in response to George's sort of broad comment, my understanding of this is that while there are cost, this program has comprehensive savings and benefits that go across the board to consumers and I think what is important about a number of these programs is for the first time we are beginning to get a level of clarity about if we were to implement energy efficient programs in the State of North Carolina on a comprehensive way that consumers across the board are going to save money in a big way because of these aborted costs. So there might be cost to some of the utilities because of loss revenue on sales and other things like that. But the reality is that overall for economy of North Carolina this is a very positive thing and I think finally we are beginning to get some of that resolution, some of that clarity that we haven't had before. And having some independent looks at this, I think, begin to make this transparent for the first time.

Dr. Eggers: I just like to respond to the comment or maybe the implication that if it were such a good idea why were we not already doing it. Maybe that was not the implication but sometimes that is the criticisms of programs like this. I think the numbers are consistent with numbers I've seen elsewhere and not surprising and I've got a house that is almost 100 years old and a couple of years ago I had installation blown into the walls and it paid back in less than two years. And anybody could have done that in the last nearly half century and had that pay back. So we don't always do things right away that are going to directly benefit us. Another thing is these numbers I think are artificially conservative in the sense that there is a proposed peaking facility Congress is proposing in Buncombe County, 120 megawatt plant. And if that plant runs ten percent of the time, based on the emissions numbers they have presented, we gave those numbers to US EPA and EPA cranked them through the models they have and then we looked into health effects, at ten percent that plant will increase the amount of money our county health department will have to spend on respiratory illness by 1.9 million dollars per year according to all the federal models. So those types of (inaudible) benefits aren't from these numbers. So I would take that into account as well.

Mr. Slocumb: There is a cost here and I guess that is what I'm trying to get a handle on that. You know maybe a few dollars on a residential customers bill is not a big deal but I'm a little concerned about major manufacturers which many of them are members of my organization and what if their power bill is a million dollars a month. What kind of costs are they going to incur and does that actually deter them from taking money that might be available to make energy improvements. Was there any discussion of how this would affect or the cost would affect significant or large manufacturers?

Mr. VonHeckle: I think the best way to say it is when it comes down to a time to actually design the programs and one percent of revenues and efficiency fund, that's a pretty significant program. You would want to make sure that all the customer groups are in the position to benefit substantially from the program. That doesn't mean that every individual customer will necessarily take up the opportunity to reduce their energy use but the idea is that most customers, the bulk of customers, and certainly every customer class will have the opportunity to reduce their energy use. Now those that participate in the program should see their bill decline from what they would have been otherwise. Those who do not participate there will see some rate impact and their bills will increase. So it really depends, like I said it is a question of fairness, you want to design the programs such that each customer class has the opportunity to participate. And if for some reason .....

Representative Hackney: Thank you David.

Dr. Everett: And I guess really what I was just trying to get to is I certainly understand that in the net if we were to take a lot of energy efficiency measures and put them in place that people's bills would reflect the improved use of electricity and therefore some savings. The thing that I just think we miss when we see it presented like this and it would be good for Bob and other individual home owners just to understand, what does this mean if in fact we wanted a program designed just like RCI2 is contemplated? How do we get that money to put those programs in place and what it would look like to the bill payer so that we would know if we were voting on a recommendation exactly what was going to happen. We know in the net somewhere out there in some period of time there is a benefit, a net savings to the customer, but in order to get there something has got to happen and that's the piece that I'm just looking to make clear to everybody then we can decide whether to do it or not.

Representative Hackney: Is there anybody that is not clear about that?

Mr. Urlaub: I think we are not clear in our discussion here because when you implement RCI2 and you successfully implement it, we are taking demands, we're reducing demand for electricity. And over a long period of time, consistently every year reducing demand for electricity starts to add up to the point that the discussion about having to build power plants ten years down the road, 15 years down the road. If we're implementing efficiency measures through this program now and next year and the year after, those add up to the point where we don't have to build as much in the future if we're permanently taking that demand off the grid. This is similar concept that applies when we require the use of renewables. One you implement a certain amount of them, we're basically shifting how we meet some of that demand from coal, nuclear, natural gas and oil over to something else. Efficiency in this case or renewables in other cases, so that's the cost savings benefit to all rate pairs ten years from now because everybody gets to avoid having to pay that additional cost for that

additional 500 megawatt power plant that we might build ten years from now if we implement all of this energy efficiency now. Then we see that lower bills for everybody down the road because we are putting less into the rate base in the future.

Senator Cowell: Just want to speak to the financing mechanism because I've been working on it for the government building piece, RCI3 which I've got a bill coming out probably in the next week or so. I think there are very low cost which can be funded through operating expense, I realize that's the exception not the rule that some of these are going to have to get into major capital equipment energy performance contracting is I think the next tool that can be used for commercial, industrial, and institutional. Those are in place already in North Carolina, we have a number of firms providing those contracts where they basically get their money back and their fees through the energy savings of that contract whatever the terms are. That is already in place in this state and for the government we've just increased that cap to one hundred million. Then I think for residential is the hardest, how do you get residential consumers to blow the insulation into their attic. I know one possibility is having a very low interest loan that could be paid through the utility bills or something like that that makes it easier. That's sort of what I'm envisioning on this measure and tell me if I'm wrong in those visions.

Mr. Von Hemple: I'm sorry the question is.

Mr. Nicholson: If you didn't hear the details ok. It was the details in terms of actual implementation, what particularly would happen. I would just ....

Mr. VonHeckle: And I think what was suggested were certainly very interesting and useful options for implementation of not just some of the options in RCI2 but several others as well.

Representative Hackney: I note that our guest have come in and let's take a pause in our discussion right now and come back in just a moment. I want to take some time and introduce our friends who are visiting with us today and I will ask you to stand and then I'll call on a couple of the leaders for remarks. We have a Member of Parliament, Michael Aneram. Welcome sir we are happy to have you with us. Another MP, Charles Hendry. Peter Kilfoyle another Member of Parliament. Bill Olner another Member of Parliament, welcome sir. And Martin Rickerd, Counsel General. Who have I missed? Alright I'll call on the Right Honorable Michael Aneram at this time, sir if you will come to well of the committee room and address us we would be honored.

Mr. Aneram: Representative Hackney, ladies and gentlemen can I say what an honor it is for myself and my colleagues to be here today. I am very impressed to see this fate of rail experience and political will gathered together in this room because this is I think is an indication of the importance of the subject of which

you are dealing with. Our visit in a sense also recognizes the importance of the challenge of global warming and climate change. I was pleased to see that in the title of your group, you call yourselves the Legislative Commission on Global Climate Change and that word global is to me a very important one because although each in our own areas are having to deal with the challenges which are going to effect us geographically. We equally have to understand that the only way of resolving the challenges overall is by dealing with it on a global basis. It is that degree of global coordination that is going to be at the basis of finding a successful answer to what is probably the most important challenge facing our generation. It strikes me that at the moment we are seeing a change in the political climate which is vitally important towards moving forward what you are trying to do here. I'm obviously not going to comment on the politics of the United States, so I am beginning to see a emerging here a consensus about the nature of the problem which I think is welcomed to us all. I can only speak for my own country where the group here today represents the two major parties, the Labor Party which is the government party at the moment and the Conservative Party which is the main opposition. Where there is a consensus of approach which is almost unique in our political history and I may say that the third major party, the Liberal Democrats are also in the same frame of mind and we are seeing what is probably the most encouraging thing in our area and that is almost a competition to be further ahead of the others in terms of how we feel with this particular challenge. And that sense of competition may be but is almost more important than anything else because the science of climate change and global warming can be done, has been done in the words of one academic I saw today, may well have been almost completed. What has not been completed is the political will across the international community as a whole. It is going to make what the science tells us needs to be done happen. And I am delighted and honored to be here today to see the work that you are doing because you are addressing the problems not just of North Carolina but you are addressing also the problems that are going to have to be taken off and effectively put into practice by the rest of the world as well. So thank you for inviting us today, thank you for allowing us to listen to your deliberations. As I say, probably in our political lifetimes this is the most important task that any of us are ever going to be asked to do because we are not just dealing with the problems of the moment we are dealing with the problems of the future, the whole question of the future of our planet. That is work worthy of the effort that you are putting in. I wish you all luck with that and I look forward to seeing the results of your deliberations in due course. Thank you very much indeed.

Representative Hackney: We will next hear from her Majesty Counsel General from Atlanta, Martin Rickerd.

Counsel General Martin Rickerd: Thank you very much Representative Hackney, ladies and gentlemen. I think Mr. Ancram has really said it all. The difference between him and his delegation and me and mine (inaudible) as well is that they represent the British Parliament and I represent the British

Government. The difference is not one that you would hear as we go about because we all agree as Mike Ancram just said about the importance of hackling this issue. I'm based in Atlanta, I come up to North Carolina whenever I can. I think this is my fourth visit. We in the Consulate General have close relations with the Commission since it was set up. We are delighted to continue that relationship. I am personally very pleased to see the Commission in action this afternoon. This is the first time I've had the opportunity to be present for one of your meetings and like Mr. Ancram, delighted to be here. I congratulate you on your work and I'll let you get on with it. Thank you very much indeed.

Representative Hackney: We are delighted to have our visitors with us today. I have some fairly substantial biographical information up here which I wish I had more time to share with you. These are very distinguished members of Parliament and distinguished leaders in their country. I do want to note for you that there is a burrow in London known of course as Hackney and I do hope you will look after it well. Thank you for being with us. Mr. Peterson if you will come back to the front we will resume our meeting.

Mr. Givens: While he coming up I would like to recognize Cindy Groff-Venman who is with the Consulate General's office and helped us coordinate this visit. Also there was an additional hand out from Jim Hagan Exhibit I), captioned Global Warming Initiatives Incorporated that will be included in the record. Thank you.

Representative Hackney: Now we are back on RCI2, does anyone have a motion to put this one on the table? Representative Harrison so moves. Is there further discussion?

Mr. Urlaub: Mr. Chairman I wanted to clarify to what extent we know what we're voting on here. Are we voting on the recommendation of the concept that is described in the first description, are we voting on some of the details that are inherent in the page description. I would like to know what the report will reflect so that I'll know what my vote is supporting or not.

Representative Hackney: Alright, let me try to answer that and others can join in. You are voting to include in the report a recommendation along the lines of RCI2 which may or may not contain all the details of it but is substantially that. Is that clear or murky enough? Further discussion, Mr. Howard.

Mr. Howard: I just want to maybe ask a question, let me first make a statement. In the manufacturing community, in particular, large manufacturers most of those folks have their own energy managers. They look at on a regular basis how they can save money which is the bottom line in their overall cost structure. How can we produce our product at the lowest possible cost? They do that every day, what we're asking them to do as I understand it, maybe I miss understand, but as I understand RCI2 we are talking about a one percent public benefits fund that

they would all have to pay. Some of our members have power bills that are in the 20 million dollar a year ball park and higher. So we are asking them to not only support their own energy managers and that investment that they make to lower the cost of their productions, we are asking them to also pay a significant amount of money annually into the public benefits fund. The other point I wanted to make has to do with this cost question. To me I try to put it in some term other than an electrical term. I can go out and I can buy a Range Rover that will take me four hundred thousand miles before I have to buy another vehicle and I'm going to spend a certain amount of money to do that or I can go out and buy a Ford that's going to take me one hundred thousand miles and I can spend a whole lot less amount of money to do that. The average might be in favor of the Range Rover but I can't afford a Range Rover. I think there is a lot of concern within the manufacturing community about the initial, what I call the start up cost of all of this.

Mr. Shore: To add a few things to what Preston just said, first of all I think there is a common agreement that there are great opportunities for us to use energy more efficiently in North Carolina and that can certainly make our economy more efficient, create jobs and have other benefits. I just want to make a comment on the scale of the numbers that we are talking about. Right in the middle of the page under goals and timing #3, the rough recommendation is that we're talking about one percent of utility revenues being invested in energy efficiency and that number I believe is quite consistent with what Duke Energy their CEO Jim Rogers has expressed a willingness for Duke Energy to put 50 million dollars a year into energy efficiency which is about one percent of their revenues. George, correct me if I have that number incorrect. So I think these are numbers that are acceptable and there are benefits to them and then finally, I'm sympathetic with Preston's point about the impact for large industrial rate pairs and there is nothing to say that we couldn't have this type of policy and also have some type of cost cap for industrial customers.

Representative Wilkins: Thank you Mr. Speaker. I'm going to be willing to move this out of here because I know it's going to get more intense debate at another couple of levels and I think we will have an opportunity to hear from these efficiency managers, my lack of a better term. On that basis I know there is going to be much more debate on a couple of levels and therefore I am ready to hear those debates.

Representative Hackney: Further discussion? Dr. Everett.

Dr. Everett: I want to confirm that number that our CEO has committed to spend on efficiency what he hasn't committed to and therefore it's hard for me to commit to come from a public benefit fund.

Representative Hackney: Fair enough. Alright all in favor of this inclusion of this one in our interim report please say aye, opposed no. The ayes appear to have

it, the ayes do have it. RCI3 – this one says that government should lead by example and improve energy efficiency in all government buildings. Senator Cowell moves adoption. Discussion? Mr. Slocumb.

Mr. Slocumb: Mr. Chairman I have one concern about a recommendation that would mandate or tie some of this program to the lead standard. There is a somewhat perverse twist in leads in that in the scoring of energy efficiency or environmental benefit, more credit is actually given to steel and concrete than wood. And in fact the only wood that can get credited under the lead standard, it must be certified under a program called Forest Stewardship Council. And there is none of that in North Carolina, so tying this to a lead standard would actually be contrary to RCI7 which calls for use of local materials. It would force really using potentially materials from a long way outside the state and on a life cycling analysis wood is far superior to steel and concrete in its environmental footprint. So I see tying this to specifically in terms of construction to a lead standard as contrary to what we are trying to accomplish with reducing emissions and environmental footprint.

Representative Hackney: Mr. Peterson you want to respond to that?

Mr. Peterson: Just to confirm a technical point that has been raised here there is substantial modeling the consortium known (inaudible) has been looking for some time through field studies at the effect of substituting wood products for conventional building materials, steel and concrete. They fair about 28 percent better in terms of embedded energy use so at a technical level your point is correct. Anything that would expand this to incorporate that form of wood products would certainly potentially enhance greenhouse gas savings of this measure.

Representative Hackney: Mr. Slocumb do you want to propose some clarifying language to go along with this as we move it along if we do?

Mr. Slocumb: I would be happy to, there are some very positive elements of lead that's only in these construction guidelines that I think we have a problem and there are certainly other green building initiatives that are far more I think I say liberal but in that they do recognize wood on a much broader scale. One that comes to mind is called Green Globes. But I would be happy to get staff more information on all of this.

Representative Hackney: Senator Cowell would you be willing to amend your motion to provide for the reasonable inclusion of this concept as expressed by Mr. Slocumb? Alright, that's what's before us. Dr. Crawford-Brown.

Dr. Crawford-Brown: One of the issues with this particular one, I'm sort of going to pitch the idea of a rider here, something like this to it. At the universities, I'm only going to speak for the universities, other organizations have the same

issues I am sure. We find it very difficult given the way in which pricing goes on for the buildings that are on our campus where the lowest bidder wins out and you don't really have a very long time horizon for calculating the savings from energy. We have a hard time getting those buildings approved through the current process and in particular getting the monies that are needed for the certification under lead and so forth. So I hope that part of this RCI1-3 there could at least be a sentence that might say something in the effect that state purchasing policies, construction policies with respect to the universities might need to be simply reviewed or something to be consistent with this one because there are a number of hurdles at the moment to getting to here at the university level.

Senator Cowell: I just want to reassure you that we have talked to President Bowles and his office and we are looking at capital planning process. I understand that that is part of the problem.

Representative Hackney: Further discussion? Alright it's been moved that we include RCI3 – Energy efficiency requirements for government buildings, all in favor please say aye, oppose no, that one will be included. RCI4 – Market transformation and technology development programs. This as I understand it is an encouragement from the private market to incorporate energy savings technologies and I would direct your attention to potential implementing mechanisms at the bottom, this is a necessity I guess at this point, a very generic recommendation. Someone want to move its adoption? Representative Harrison does along with Dr. Smith. Discussion?

Dr. Smith: I just want to make a quick comment that there is a group doing market transformation work throughout the southeast, the Southeast Energy Efficiency Alliance and I think this was a program that has done quite well in other parts of the country and so I would just encourage people that anything we can do to get more efficient products and transform the market that way through initiatives like this have proven to be very valuable.

Representative Hackney: Further discussion? If not so many has favored the adoption of RCI4 for inclusion in the report, please say aye, oppose no, the ayes have it. RCI5 – Improve appliance and equipment efficiency standards the replication of standards adopted in other states for appliances and other equipment. Is there a motion? Representative Harrison moves. This is a policy, further discussion? Mr. Howard.

Mr. Howard: Mr. Chairman could I ask are there any other states in the southeast our region that currently or have already done this? The text talks about developing regional type approaches, I'm just curious because I don't know.

Mr. Peterson: David do you know the answer to that?

Mr. VonHeckle: Not to my knowledge is the answer – I know that there was a recent report out of Florida on energy efficiency potential so there is some consideration of it going on down there but not to my knowledge. There is a lot of it going on around in other parts of the country however.

Dr. Crawford-Brown: There is part of this I just need some clarification on. Is the proposal here that the state will in its own activities adopt energy efficient appliances or is it literally something like if you want to sell your appliance here in the State of North Carolina it has to meet the following energy efficiency requirements? I am not clear on that.

Representative Hackney: The latter.

Mr. Howard: Is it contemplated that some of the funds that will generate in the public benefits fund program would go to offset costs for low income users to purchase these more expensive appliances?

Mr. VonHeckle: I think that certainly is a possibility. I think again that's a design issue for how the funds that we collect in RCI2 might be spent but it certainly is an opportunity there.

Dr. Smith: I would also, Preston for your benefit, I know that some of the discussions with the market transformation mechanisms there is one of the ways to lead to that is to provide incentives that could help buy down the cost delta between a more efficient product and one that may be standard. So I think there are actually two programs that could benefit from. I think the benefits fund and the market transformation mechanism could potentially do that.

Representative Hackney: Further discussion? Dr. Chukwu.

Dr. Chukwu: Trying to wonder if there are examples of their plan?

Representative Hackney: Examples of the kind of appliances we are talking about, refrigerators, washer, heavy equipment?

Mr. VonHeckle: Yes it does include appliances that are now under federal standards. But for which some states are considering higher federal standards which might include washing machines, dish washers, refrigerators. But it also includes equipment and appliances that are not now included in federal standards but for which some other states have considered some types of efficiency standards and these might include for example commercial refrigeration.

Representative Hackney: Can our fans from the UK, can you tell us if you have the high efficiency standards that are mandatory for appliances? Do you have that?

Mr. Ancram: Mr. Chairman we do have mandatory requirements on certain levels such as the minimum standards that you require but of course there is a difficulty because we are in the single market in Europe and it is possible to bring things in even across the English Channel that don't necessarily match up to those standards.

Representative Hackney: Thank you.

Mr. Ancram: Mr. Chairman could I just add briefly to that as well, across Europe there are standards of energy efficiency which are white goods, so fridges and items like that have to show and so there is a star rating for that. And the discussion of the moment of whether that should be applied to brown goods as well so other electrical goods so the debate which is taking place now at this time.

Representative Hackney: Thank you for that contribution. Further discussion? If not so many as in favor of the inclusion of RCI5 – Improved appliance and equipment efficiency standards please say aye, oppose no, and it will be included. RCI6 – Building energy codes. The international energy conversation code 2000 is the model, is that the current model or the desired model?

Mr. VonHeckle: I believe that is the current model.

Representative Hackney: Alright so we would be proposing code amendments to adopt more stringent codes to improve energy use in buildings, adopt innovative features, statewide enforcement of existing and new codes at all levels, regular updates, modify codes to remove obstacles to renewable energy use, and education for building inspectors and professionals. Is there a motion? Senator Cowell. Discussion? Representative Wilkins.

Representative Wilkins: Thank you Mr. Chair. Mr. Peterson I'm for the moment going to assume that this will cause probably the number of inspections and inspection fees to rise, would this be correct?

Mr. Peterson: The question is whether the number of inspections and inspection fees would increase under this option versus the base line?

Mr. VonHeckle: I'm not sure whether the number of inspections would increase but I think it's probably a fair bet that the stringency of inspections would increase and that inspectors would need more specialized training in energy efficiency.

Dr. Eggers: Did ASTM not announce that they were going to go to 30 percent more efficient for base building by 2010, maybe we could amend this to have the numbers reflect that if that has been made public by ASTM.

Representative Hackney: Did you hear that David?

Mr. VonHeckle: I am sorry I did not hear.

Dr. Eggers: Do you know about ASTM basic numbers going to about 30 percent more effective by 2010?

Mr. VonHeckle: I guess I still am not picking up the exact question. I'm sorry.

Mr. Peterson: ASTM numbers, David.

Mr. VonHeckle: I'm sorry could someone repeat the question please?

Representative Hackney: ASTM energy use standards are to be raised by 2010 true or not? And relevant or not to this discussion?

Mr. VonHeckle: I guess I'm not sure about the answer to that.

Representative Hackney: OK. Of course in some cases the increase in national or international standards can render superfluous whatever this sort of thing does.

Mr. VonHeckle: Yes that is true the idea here is that these would be more stringent than national/international standards. That they would sort of push the envelope to be more efficient than the average and certainly what is being implemented today in North Carolina.

Dr. Crawford-Brown: I like this particular one right here, hope you can adopt this one because what we've learned in England for example is that until a municipality can point to the federal government, the national government on building standards they were very loathed to stand up to developers because they would just lose the battle. Our municipalities in North Carolina tell us the same thing, the municipality needs this leverage to be able to tell new developers that energy efficiency criteria is going to be considered. So this is an important one I think.

Representative Hackney: Further discussion? I forgot what we have a motion on Mrs. Utley do we have a motion? Senator Cowell moves the adoption of RCI6 – Building energy codes. Further discussion? If not, so many as in favor of that motion please say aye, oppose no, and it will be included. And like all of the others Representative Wilkins, subject to a lot of future debate. RCI7 – Beyond code building design incentives and targets. It is not very specific I would note,

to provide incentives, doesn't say who will pay for that either, presumably state tax credits or something like that. Mr. Peterson can you ....

Mr. Peterson: Mr. Chairman I would just add that this goes for all of these litigation options, there is a far more detailed description in the appendices that we provided as a part of the discussion today and this particular case it's a couple of pages worth of specifics of that that have been out there for discussion within the CAPAG and work group at some point for some time. David certainly could elaborate on some of the specifics but I do want to note that we have a tremendous amount of detail behind this one page summary.

Representative Hackney: Well I guess it's of note that this is a goal, it's voluntary, its part of the cost is borne by the incentives and so it's an attempt to use the private market plus a little bit of government incentives to achieve the goal. Is that a fair description of it Mr. Peterson?

Mr. Peterson: David did you hear that?

Mr. VonHeckle: Not entirely I'm afraid. Did ....

Representative Hackney: Representative Wilkins.

Representative Wilkins: For a motion Mr. Chair whenever you're ready that it be included.

Representative Hackney: Representative Wilkins moves the inclusion of RCI7 – Beyond code building design incentives and targets. Further discussion? If not so many as in favor of inclusion of the motion, please say aye, oppose no. The motion carries. RCI8 – Education at all levels for builders and contractors, for building design related professionals, at community colleges and trade schools, consumer education, state energy office, school curriculum. This one will get a fiscal note when it gets introduced as well. Representative Harrison.

Representative Harrison: Motion for inclusion.

Representative Hackney: Representative Harrison moves for inclusion. Further discussion? If not so many as in favor of the motion, please say aye, oppose no, that one will be included. RCI11 – Energy and emissions technical assistance and recommended measure of implementation for the residential energy audit program, commercial energy audit program, industrial energy audit program, follow-up mechanisms and incentives and financial assistance. Parties involved: utilities, state agencies, efficiency providers, regulators and others. David are you there? Can you give us a little more specifics on is this intended to be a State Energy Office run program or .....

Mr. VonHeckle: The idea was that it would expand the number of audits done every year. Quite a lot and would offer, once the audits are complete, would offer some incentives to the consumers whose premises have been looked at to implement some of the suggested options. These could be done through the Energy Office, could be done through an expanded set of different agencies. Does that answer your question?

Representative Hackney: I think so. Is there a motion?

Mr. Urlaub: Our organization and our work with the Utilities Commission employee of the Industrial Extension Service who provides such services in the industrial sector told us that his funding only enabled him to do about 40 such audits for say medium and small size industrial entities, manufacturing facilities, others who are often small enough that they can't afford an energy manager and so they were filling their annual quota, so to speak, within about a month and a half or two months. So he was finding a lot more demand for such services than they were able or funded to supply.

Representative Hackney: Further discussion? Is there a motion?

Representative Wilkins moves adoption. Further discussion?

Representative Wilkins: A comment with that please. While I don't agree with everything that I see under RCI11 I certainly agree with the attempt and I think it needs to move on.

Representative Hackney: So many as favor of inclusion of #11 please say aye, oppose no, the ayes have it. I believe we have concluded that category, is that right Mr. Peterson. David thank you very much for your assistance.

Mr. Peterson: Before we excuse David I would actually like to have him pinch hit for the next one if he might.

Representative Hackney: Ok David it is ES3 and ES9. Are you with us?

David: I'm sorry is the question directed at me.

Mr. Peterson: David, I'm wondering if you could, in Bill's absence, if you could do a quick walk through on the combined heat and power options. They are combined into a single option, these were originally separate and then following discussion in the work groups and the recommendations to the CAPAG, these were lumped together.

David: On ES3 and 9. Let me just get there please. Right, so removing barriers to CHP which is combined heat and power and queen TG that's distributed generation, here the idea is to, and this echoed in one of the options currently

under discussion still pending in the RCI group. The idea is to work with utilities and regulators to make sure that some of the technical and also regulatory barriers to implementing combined heat and power that is sited on the premises of consumers and (inaudible) generation will be removed. And this means a combination of (inaudible) for interconnection of these facilities and also rule for how much of that power that flows back into the grid how much will be paid for that power.

Representative Hackney: Further discussion?

Representative Harrison: I'll move for inclusion.

Representative Hackney: Move for inclusion. Ms. Choi.

Ms. Choi: I just wanted to point out that the idea of a 20 megawatt or smaller having a standard agreement is somewhat troubling to us because currently the small interconnection agreement is at 100 kilowatts. So as you move up in size having a standard agreement, it is difficult because there is more complexity in connecting these larger systems. And I would ask that perhaps instead of doing it command to control policy here we request that the Utilities Commission study the idea and make the recommendations on the best way to move forward to promote interconnection.

Representative Hackney: Alright, Representative Harrison do you want to accept that as a friendly amendment or fight about it?

Representative Harrison: I'll accept it as a friendly amendment because I think the Utilities Commission is going to have to implement this anyway.

Representative Hackney: The motion before us is that the Utilities Commission be requested to study cogeneration to encourage cogeneration systems and to find ways to put them into service. Is that reasonably clear enough to the drafters?

Dr. Smith: I don't necessarily disagree with that I just do believe that it would be important that we send a signal to the Utility Commission that allowing larger megawatt interconnection is going to make this a more effective strategy for dealing with greenhouse gas emission and global warming. (Inaudible) back to our speaker that we had on combined heat and power a few times ago and I think he was sending a very strong signal that it is important that we get the rules correct on this and I would recommend we accept the friendly amendment with the caveat that we would like for the Utility Commission to go higher than the current standard because it is a constraining standard. I understand there will be some additional complexity but I think it is important that we get a higher megawatt figure in order for us to get more cost effective combined heat and power onto the North Carolina systems.

Representative Hackney: Further discussion?

Mr. Urlaub: Thank you Mr. Chairman. To get just a little more specific it may be helpful in this instance because we have a specific number of 20 megawatts here. Federal Energy Regulatory Commission has interconnection standards in place, language in place, directors in place for states at the two megawatt level. And so our state is currently up to 100 kilowatts and we currently have a gap there where we don't have an interconnection standard in place between what we have and what the federal government has between that 100 kilowatt and two megawatt level. So perhaps if we wanted to get specific, we could talk about exploring that increase to the two megawatt as opposed to the 20 megawatt or looking into it.

Mr. Howard: Mr. Chairman, my understanding the motion to be that we are giving the Utilities Commission an enabling power to actually do this, they are not just going to study it. I am in the camp that says we need to do this.

Representative Hackney: I think the motion is we are requesting them to study it.

Ms. Choi: I believe they have the power to do that already so I don't want people to think that we don't already connect larger than 100 kilowatts to our facilities we have and will continue to do that when those providers come to us to (inaudible) order here is for those connecting for wholesale sales and this idea would be to connect if they are going (inaudible) for retail sales. The other concern is the sales to third parties that is under state law, that is equal would mean they are a utility and treated as a utility and I want to make sure that we would want that to be done here. I'm not sure that was the intent of this recommendation. But I think the Commission already has the authority to do that.

Mr. Howard: I think we handcuff ourselves by requiring those parties to be a licensed utility if they want to sell to a neighbor.

Mr. Shore: Co-generation is where we're going to burn fossil fuels and it's one of the best ways to improve efficiency. We can double the efficiency from say 35 percent to nearly twice that. This is a great economic opportunity to use energy more efficiently and if the motion that goes to the Utility Commission, not just to study it but to really pursue ways to remove barriers and promote combined heat and power, I think we should do that.

Representative Hackney: Ms. Choi if I was reading you correctly, you mainly wanted to get the numbers out right? The specific numbers?

Ms. Choi: Right.

Representative Hackney: So if it encouraged the Utilities Commission to study ways to move toward co-generation, you would be ok with that?

Ms. Choi: That is fine.

Representative Hackney: Alright. Dr. Smith.

Dr. Smith: I think I understand. I just want to make sure that we are sending an unambiguous, because I agree with Preston Howard that the Commission needs a clear signal from us not just to study this more but to actually get on with getting more combined heat and power into our grid because there are tremendous opportunities for customers and for the environment.

Representative Harrison: Thanks Mr. Chair. I'm with you on that Dr. Smith and Preston. I think that from my perspective I would hope the Legislature could remove any constraints that are currently existing for co-generation.

Representative Hackney: Alright with the understanding that the motion is as stated by Ms. Choi, as amended by Dr. Smith and Mr. Shore.

Mr. Givens: Let me tell you what I think that means and you then you tell me if I'm right or wrong. I need to be clear about this one because this one is actually easy to implement, I could do this by writing a letter. Basically I think that I agree with Ms. Choi that the Utility Commission currently has the authority to devise an interconnect standard and if there is a gap, it's my understanding between 100 kilowatts and 20 megawatts. We can certainly request them to open a docket on an interconnect standard to fill that range. I assume that there may be other barriers to provide heat and power and we would ask them to study what other barriers there may be and report.

Representative Hackney: Alright so we have a most specific iteration you just heard from Mr. Givens, anybody have a problem with studying it that way?

Mr. Shore: Just to add to the last sentence that Mr. Givens just stated to study those additional barriers and seek to remove them.

Representative Hackney: Alright let's try that one out.

Mr. Shore: Is it to report back to this Commission or who will the Utilities Commission be reporting to?

Mr. Givens: Why don't you leave that part to me and I'll talk to the Utilities Commission and see what their time frame is and they can report to this Commission or they can report to the ERC depending on how long it's going to take.

Representative Hackney: Or they might just do it.

Mr. Givens: I think we might want to know, I think they are happy to report there is another oversight commission for the utilities that hasn't met in a while but may be meeting – so we can work that out. I understand if you wanted to say not just report but to do what they can on their own. I can sort of word it that way.

Senator Cowell: I just wanted to echo that if those barriers are easily identifiable and we can take action on them now, I would like to do this now and not have this delayed until after the long session. This is one of the most compelling pieces that I've heard in this whole Commission and I just think it's a no brainer to do and if there are technical questions that need to be asked about size I certainly think that is relevant but I don't want to wait nine months to hear.

Mr. Givens: The Utilities Commission functions year round – they go at their pace. I think that the question of the interconnect standards itself is quite complex and technical and I've got an idea it will take them until next interim to, I think if we set them on this task now that we will not have lost some time.

Representative Hackney: So many as in favor of the motion please say aye, oppose no, the ayes have it. Whatever it was we adopted it.

Mr. Givens: Mr. Chairman I regard that as the one that is the clearest because I know how to write a letter – I am not sure I know how to write these bills.

Mr. Toben: Before we leave the energy supply and technical working group I served on that group with a number of the folks in here and there is one item which if the folks want to reference it on the web site it's the energy supply item #2 which is a renewable and energy portfolio standard. This is an item that did not receive unanimous consent it was an item that I think it can be fairly said had general support among the CAPAG where there was still discussion in the decision to return it to committee was around the actual value of that proposed renewable and energy portfolio standard. The proposal that was under consideration was a twenty percent RPS ramping up from current time to the year 2020 and what I would like to propose for the record is that an acknowledgement be given that that item represents one of the top three potential items in terms of both reducing greenhouse gas emissions and providing significant economic benefit to the state. And while I understand that we are not at a point in the CAPAG or with the energy supply twig to recommend a specific level, I do think that it's worth giving. This Utilities Commission has conducted a study on this item and CCS and DENER have committed significant time and analyses to this item that we acknowledge that it is one that warrants very serious consideration and further study and that it could potentially be one of the top, if not the top yielding item among the recommendations that come from the CAPAG.

Representative Hackney: Mr. Toben I will note for you that on page 23 it's on the agenda coming up. CC1 – page 17 Greenhouse gas inventories and forecasts.

Randy Strait: The purpose of this recommendation is to establish an inventory and forecasting function with the state in order to track greenhouse gas emissions and emission reduction. They were pulled from various data sources, they would integrate it with their existing programs for developing inventories and forecast for other pollutants.

Representative Hackney: It's not clear to me who would do it.

Randy Strait: Ok and this function Mr. Chairman would reside with the Department of Air Quality (inaudible).

Representative Hackney: Ok you're going to have to speak up and speak into the microphone as you address us all.

Randy Strait: Ok thank you.

Representative Hackney: Discussion on this?

Representative Harrison: Thank you Mr. Chair. Is this voluntary registry?

Randy Strait: No this is an inventory and forecast – this function would reside with the state and they would implement it.

Representative Hackney: Information would be gathered from whatever sources were available? Is that correct?

Randy Strait: That is correct.

Representative Hackney: It may or may not be. Speak in the microphone please.

Mr. Peterson: This is not the same as a registry system, we'll take up in just a minute which is more detailed – so this is more generalized in terms of state wide activity based emissions in tracking program level reductions, etc.

Representative Hackney: Before we vote let's run on through the rest of the CC's. State greenhouse gas reporting is the next one on page 18.

Randy Strait: Ok this particular recommendation would apply to the sources or the generators of the greenhouse gas emissions folks that own the emissions and what this does is set a framework for them to quantify on the (inaudible) established to quantify their emissions and that would set the standard for entering or participating in a registry.

Representative Hackney: Alright and CC3.

Randy Strait: CC3 is the registry recommendation that the state would engage with other states and look to joining or setting up. Let me back up, there is a regional and even a national effort to establish standards for a regional or national registry and its participation in that registry would be by (inaudible) in many states. So this recommendation is to encourage the state to participate or look to joining a national or a multistate registry at the regional level. What the registry does is allow entities that prepare their emissions code in the reporting protocols to record their emissions with the registry as well as the (inaudible) reductions. And it includes the transaction ledger capability in order to one establish base line and quantify emission reductions.

Representative Hackney: Alright we have CC1 which provides for inventories and forecast, CC2 for the voluntary reporting so that you can get credit for it if you want to register it and then the registry itself which will provide a central place to record the reductions so that if you want to sell them or get credit for them or get money for them or whatever you can use the registry for that purpose. Everybody understand that question?

Dr. Riggs: I think it's great that we analyze for CO_2 and greenhouse gases but it doesn't do a darn bit of good if we don't look at the consequences of that. It's all these greenhouse gases that are going to cause these problems and I don't see that in here anywhere. You've got inventory of the greenhouse gases, you do not have inventory of the consequences, even in your #5. We know what the impacts are going to be but you don't have anything in there for monitoring these or developing a basis for knowing what those impacts are here in North Carolina.

Representative Hackney: Alright give some thought Dr. Riggs as to how you would amend one or more of these policies as we get ready to vote on them.

Dr. Crawford-Brown: Two quick comments. One is that for these things to be really helpful particularly for people who work at the municipal levels who it would be useful if this were not just a state inventory but if it were possible to break it down to the municipal level. And we've found that to be possible because the help that Duke and so forth have given us in getting information about energy use in particular municipalities. The second thing I would say is, I know Brock wants a lot more work here and to be able to do this, I do want to make a pitch for the fact that around the country the state seems to be having the most success in moving forward on carbon dioxide reduction. Our states that have a pretty powerful energy office and I don't see the State Energy Office in here in the listing here. I know Larry is in the back there, but it seems to me that a state energy office is an important player in this and I'm a little disturbed that they don't appear in the language here.

Representative Hackney: Alright and you might be looking for a good place to put that one too.

Mr. Profeta: I just like to give a statement in support for 1, 2, and 3 here. As I've been observing the debate and also some of my fellow commissioners on the utilities we've been talking about how (inaudible) moving forward right now and there's a question of how this state positions itself in preparation for a possible federal program that's being debated in Washington as we speak. If we're going to have a market base system in greenhouse gases in this country, the first movers should have a place to register their emissions so that the value of their early movement can be reflected in the eventual program. So I think this is a way, not only for North Carolina as a plan person in CC1, it can plan its path forward to adjust to the future that's coming in terms of greenhouse gas restrictions. It can do an inventory in reporting of itself so it knows where its emissions are and the first movers within its state can be encouraged to take those actions and get that positive progress greenhouse gas in state. And also get the investments of investors who are strictly in the carbon market because they know they can register those reductions that might be coming to this state. So this infrastructure really does position NC in terms of the eventual federal program and therefore I wholeheartedly support it.

Dr. Riggs: I would recommend that someplace in here and I'm not sure where in these three. I think what is there is good but I think there is a big gap in it and I would recommend that maybe you take a look at Recommendations 3 and 4 from the Riggs/Stevenson/Clark proposal and some how or other develop a monitoring inventorying system of the consequences. That's the other side of the couplet here we need to know what the greenhouse gases are but we also need to know if there is a consequence developing.

Representative Hackney: It seems to me as simple as adding possible consequences to #1, does that do it?

Dr. Boyles: A part of the follow up to that is there currently a greenhouse gas monitoring system for the state like you monitor other pollutants out there or should that be established as part of the greenhouse gas inventory?

Representative Hackney: Brock Nicholson is shaking his head no.

Mr. Nicholson: No there is not present a monitoring system. I think responding to Dr. Riggs suggestion whether it's in #1 or in the adaptation, I think monitoring-chronicling the consequences I think would make a lot of sense.

Mr. Profeta: May I ask Dr. Riggs if we adopted his recommendation later in the agenda on an application strategy, would that successfully account for your concerns about these as well or is it in addition to that?

Dr. Riggs: No it would as long as it's an integral part of it but if they become separated at some point in time and the greenhouse gas thing goes off in one direction and the monitoring goes off in another direction. I think that what is important is the relationship between these two and one's a driver, the consequence is that we need to be on top of it and know how fast those are happening.

Mr. Profeta: Would the Chair entertain a motion to bring Dr. Riggs proposal forward and marry it with this in terms of how it is written up in the report?

Representative Hackney: Alright are you moving 1, 2, and 3 with such a merger?

Mr. Profeta: Yes I think that's a good way for it.

Representative Hackney: The motion before the committee is to include CC1, CC2, CC3 with the Riggs' inclusion of possible consequences as an amendment to #1. Further discussion? So many as in favor of the motion please say aye, oppose no, that motion is adopted. CC4.

Randy Strait: CC4 – Education – public education outreach. The recommendation is stateld by example but that was in a proactive public education and outreach capability. That would be coordinated through the NC Department of Environment and Natural Resources and being coordinated with several state agencies and the outreach activities would be pointed for five target audiences which are listed here in the proposal or the recommendation.

Dr. Riggs: I so move.

Representative Hackney: Dr. Riggs moves adoption of CC4, discussion?

Representative Harrison: Thank you Mr. Chair. I just wondered how that differs from RCI8 – it sort of compliments it since it's more focus on climate than efficiency?

Brock: It's not RCI's program as focused on the activities within that particular sector. This is broader it covers all sectors and all activities, so it's just much broader in scope.

Representative Wilkins: Thank you Mr. Chair. I would be just a bit more comfortable if we would name these other players. We're talking about DPI, community college system and that kind of thing. I would just be a little more comfortable if we stated that.

Representative Hackney: Well you're talking about where it says parties involved NC DENER and many other key parties and it doesn't say who they are?

Representative Wilkins: Yes sir.

Representative Hackney: Alright can somebody tell us who they possibly might be?

Dr. Boyles: I think some of these are included in the appendix. There is a long list of possible people that are included I think, either Brad can give us who is included. There is quite a list – I wonder if we can look some of those up real quick, find someone who can go down the appendix on line and look at the long list?

Representative Hackney: Anybody just remember Brock?

Brock: I don't recall all of them but certainly we could and Tom do you have it on your computer there?

Representative Hackney: Alright let's displace that one and go to CC5 – Adaptation strategy. State must develop a plan to manage the projected impacts of ongoing climate change including a state sanction, blue ribbon commission on adaptation to climate change to develop a plan. Includes the following A-G, state legislature should provide funding, I guess that line could be in all of these couldn't it? Alright proposal for a blue ribbon commission standing alone from state agents.

Dr. Riggs: What's on that paper I think is very good with respect to sea level rise. One of the things that is really critical to the State of North Carolina and I don't think the state is really ready for this yet. But if a Katrina or an Ivan or Rita came ashore, yes we know that we need to get the National Guard out there, we need to get the evacuation we need to get the Red Cross. But there is nothing in place in the State of North Carolina to deal with a ten year catastrophe that's going to blow the economy. I just finished a long lecture tour out at the coast and worked a series of workshops and nobody out there is thinking about what happens if one of these storms comes across the islands this summer and we blow out four inlets for example. If that happens we're looking at ten years minimum impact on the economy. And I think what we need in here is a statement some place in this dealing with the potential of a catastrophic event which could severely impact the economy of North Carolina. We need to start thinking about that right now and start to put together a framework in which to move forward with that. So I'm just recommending an additional sentence in there to acknowledge the criticalness of these figures if and when they happen.

Representative Hackney: We have a motion.

Dr. Boyles: I would like to offer the motion and under that there is a state hazardous mitigation plan and one more FEMA is starting to look at these climate changes used as being a part of that. So I would like to add language to this to

suggest that if the Commission set aside to have it as an independent group that it includes the leadership for the State Hazardous Mitigation Plan as well.

Representative Hackney: Let me pause the meeting to recognize that our visitors are going to have leave and.

Mr. Ancram: Mr. Chairman, can I say that it's been a privilege. As my colleague said earlier, it is a global matter and I should think the conversations that we've listened to today could be very much equal and probably merit the United Kingdom and hopefully around the rest of Europe and the rest of the world. Thank you very much for giving us the opportunity to come and be with you today.

Representative Hackney: Thank you for being here with us. Back to you Dr. Boyles, you made a motion?

Dr. Boyles: Correct and that we also add language to include the involvement of the State Hazardous Mitigation Planning Group that's organized through Public Safety and Crime Control.

Representative Hackney: You've heard the motion.

Dr. Smith: Again, I was just lending support having recently been down in New Orleans and seeing how they're still struggling down there I really do believe that being more thoughtful and proactive would have made a huge difference in many ways. They are sort of kicking themselves for not having listened to some of the potential forecast and I think we know that story and we would just hate to see it repeated in this state.

Mr. Clark: This is both a comment and a question. At some point during our former meetings we had discussed the whole issue of hazard notice for buyers of property in the ocean front area and I was wondering is there anything that's been done about that in the Legislature and if not is that some sort of recommendation we might want to make as part of this package.

Representative Hackney: I believe I will refer that question to Representative Harrison who has some history with that matter.

Representative Harrison: I've actually been at that request when we submitted our recommendations. I guess it didn't make it into the summary but I plan on introducing the legislation again so I look forward to working with you on it.

Mr. Clark: Would it be helpful for this particular Commission to support that type of recommendation?

Representative Harrison: I think so.

Representative Hackney: Alright further discussion? Ok we have some lack of clarity on the part of our esteemed queen's counsel here. What's the question?

George: I want to make sure I got all of it, we're going to include a reference to major storm events per Dr. Riggs and the State Hazardous Mitigation Planning Group according to Dr. Boyles and (inaudible) had his disclosure and add all three of those in, is that what we're doing?

Representative Hackney: That's the motion.

Dr. Riggs: Mr. Chair, in the Riggs/Stevenson/Clark set of recommendations #7 has some wording that deals with what Walter Clark just talked about.

Representative Hackney: Further discussion, if not so many as favor of the recommendation being included please say aye, oppose no, so it shall be included. CC6 – Options for state greenhouse gas goals or targets. Voluntary goals to limit greenhouse gas emissions to prepare the state's economy for the likely caps at the national level. Discussion?

Dr. Smith: I think this is an important part of the whole purpose of this Commission and I would like to move that we adopt moving forward on it.

Dr. Crawford-Brown: I'm not sure what an implementing agency means in this case? Is this the agency that's charged with developing the actual target or is it the agency that's charged with implementing whatever the actual target is once it's been set? My understanding it would be the latter.

Randy Strait: The target would be set by the powers to be and then these would be the agencies that would implement.

Dr. Crawford-Brown: Would the powers to be be the General Assembly or something?

Randy Strait: Yes.

Representative Hackney: Mr. Givens points out that one of the charges of the Commission is to do exactly what we're asking someone else to do in this CC6, do we actually want to do that?

Representative Harrison: I was just going to comment on the fact that I would prefer that we set a cap and that I'm happy to see that we setting a goal.

Dr. Smith: My sense is that yes this was what we were established to do and there was sort of a threshold issue about once we had heard enough science, enough background, some of the preliminary analyses was done, should we

move from the word may set a goal to shall set a goal and I think it's an appropriate thing for this entity to do in the second half of this work to deliberate on establishing what that goal should be or cap and I think what I would propose is that we formally vote on the fact that we are moving in the second half of this Commission to come up with a (inaudible) reduction goal for the State of North Carolina or cap.

Representative Hackney: As opposed to asking someone else to prepare it or recommend it. Alright, Dr. Smith has so moved. Does everybody have clarity on this one, instead of asking someone else to do it we are going say that we are moving toward during it in the next year of this Commission to try to set a voluntary goal. So many as favor of the motion by Dr. Smith please say aye, oppose no, the ayes have it. We skipped CC4 – Public education and outreach. Who are the other key parties you were going to look them up on the computer. Tell us who the other key parties are.

Mr. Peterson: Yes, just to confirm what Dr. Boyles had said and we have an annex posted to the cost cutting issues appendix. It's lengthy, the agreement on the CAPAG meeting was to separate out that very lengthy set of suggested design elements of an education and outreach program into a separate document as suggested examples of what could be involved in the program. This is a list is six pages long in terms of essential parties that can be covered. But just to summarize the general approached target key audiences as an effort below, quote walking the talk in terms of the state's own efforts. In outreach activities the policy makers, i.e. legislators, executive agencies, regulators, etc., future generations, community leaders and organizations, business and industry and half the general public in terms of audiences. Then there is some detail in terms of potential ways in which that might be done follows in some length. So there is substantial detail in terms of potential approaches that could be used there that covers a variety of potential implementing parties.

Representative Hackney: Alright, is there a motion for #4? Dr. Riggs so moves. Discussion?

Ms. Thomkins: Is there an example of how this would be done or is there a state public relations department, what will be the state's word on guiding citizens to do any of this?

Representative Hackney: Anybody have an answer to Ms. Thomkins' question?

Brock: One of the options that we think would fit pretty naturally is our on-going air awareness program would be one but certainly not limited to that. And that takes various forms in terms of input at the public school level and interacting with the Dept. of Public Instruction and just the general public too. So I would think it would include those kinds of things but I believe also somewhere in the list we are talking about the need to develop programs at the community college

level to train the technicians as well as college level for the science and technical type programs too. So it is fairly broad in the sense and with many small individual pieces to it.

Dr. Riggs: The State of North Carolina is building a brand new museum right across the street from us here in the next year. It's going to be a hands on science oriented thing (inaudible) is running on it's a beautiful format for laying this whole program out there to the public.

Representative Hackney: Further discussion, if not so many as favor of the motion please say aye, oppose no, the ayes have it. Unless I've missed something that completes the CAPAG win-win proposal, and I think what we have left to do is to consider whether to include or consider the individual suggested items which begin on page 23. I would note for you that we are moving towards the five o'clock hour and would hope that you would pick and choose carefully those things that are pretty far along and fit our general criteria.

Mr. Urlaub: Thank you Mr. Chairman, if I remember correctly that the votes that occurred at the last Climate Action Plan Advisory Group meeting that we missed an item which was the ES2 - The environmental portfolio standard. While we did not agree there was one vote against actually recommending ES2. If my memory serves me correctly, we did have a vote that generally the concept would go forward in the recommendations, the concept of an EPS environmental portfolio standard, without a target applied to it. And that it was sent back to the working group because the 20 percent was large enough that it would actually meet all of the expected electricity demands and go beyond that. So the work group wanted to look at the target level mark. If that is correct, could Mr. Peterson speak to how that is addressed and or how we are following up with that?

Representative Hackney: Mr. Peterson do you want to address the question from Mr. Urlaub?

Mr. Peterson: Thank you. Our understanding was that there was one vote against the specific proposal at the time and it was as consequence not a unanimous consent and would be considered further by the CAPAG and the work groups. As a consequence we did not include this as a recommendation of general principle, but you are correct that there was a full agreement on the general principle there was not a full agreement on the specific recommendation that's why it doesn't appear here today.

Mr. Urlaub: I so move on the basis of Mr. Peterson's reply that the Commission now consider putting forth a recommendation or voting on a recommendation that the concept of an environmental portfolio standard under ES2 without a specific target, is a policy that we want to put forth or we want to recommend.

Representative Hackney: Alright, we want to recommend an environmental portfolio standard, is this different from the renewable standard?

Mr. Urlaub: No Mr. Chairman it is what was considered under ES2 as a 20 percent by 2020 target, met by one third renewable energy and two thirds energy efficiency.

Representative Hackney: But I thought you said we took the percentages out.

Mr. Urlaub: Yes but now my motion wouldn't have a specific percentage because what we agreed on in the Advisory Group was that the concept was agreeable to all but the target needed further scrutiny.

Representative Hackney: Alright, does everyone understand the motion?

Mr. Howard: I'm not sure I do. Are we voting on a 20 percent energy portfolio standard?

Representative Hackney: No, just having one or some percentage.

Mr. Howard: And who will decide that?

Representative Hackney: Legislature. Discussion?

Representative Wilkins: Thank you Mr. Chair. I believe we already have a bill in to this effect, do we not? I'm not really comfortable with having this jump at us at a late moment in committee, although I'm going to go along with it because again I know there's going to be plenty of debate down the road. The other thing in respect to Representative Harrison is that I want to point out that this is sort of a moving target but still I'm ready to go along with the concept.

Representative Hackney: Alright, so many as favor of the motion please say aye, oppose no, the ayes appear to have, the ayes do have it. Alright, from among the list on pages 23, 24, 25, 26 are there additional motions having to do with inclusions in the interim report? My sense is that many of these are appropriate for later inclusion if at all, but I don't want to discourage anybody from a motion if they want to make such a motion.

Mr. Profeta: I would like to move my proposal #8 that has been distributed to all the commissioners, it's a proposal to create an incentive fund to (inaudible) the conversion of hog lagoon spray field technology to other technologies on the basis of the green house gas savings that result and the methane emission reductions when you do convert the technologies. When Mr. Chairman you proposed we search that win-win proposals I couldn't find one that I thought qualified more than this in this state that knowing when you put discussion of the hog lagoon issue, but we have testimony from (inaudible) climate change about

their great interest investing in conversion of hog lagoons to digesters and other technology that would destroy the methane and their willingness to pay some price to do so we have the press conference on Monday with the Pork Council, Progress Energy and Smithfield announcing the desire to explore the conversion to digestive technologies. I have had conversations with Climate Change Capital which is a London investment group, sorry our friends have left us from London, who invest in such projects in the state. I think if there could be a sort of (inaudible) fund that would demonstrate the concept on the basis of greenhouse gas savings you could finance the conversion of these lagoons that you might be able to make a lot more investments in it and so I would move that recommendation be adopted.

Representative Hackney: Let me see if I can restate it. You're specifically moving that we recommend incentives to encourage the management of hog manure to make electricity? Is that what you're doing?

Mr. Profeta: The proposal that's structured is not only for the generation of electricity but there is a number of technologies, super soil technology has also established that it will destroy methane and reduce greenhouse gas emissions, it's a composting technology, not a digester and electricity generation technology. My proposal is that we create a fund that you competitively bid to for incentives based on greenhouse gas savings and that projects bid to that fund whichever technology they want and receive funding on the basis of the greenhouse gas reductions they can achieve by converting the hog lagoon technology.

Representative Hackney: Alright, Ms. Iddings you got that down?

Mr. Profeta: I believe Mr. Givens received the recommendation, the summary and some draft language is that correct?

Mr. Givens: This is one where we actually have subsequently received some draft language.

Representative Hackney: Alright, let me try it again. It's an incentive fund where those who are in the business could ask for funds to convert to cleaner technologies for the management of hog manure? Is that right?

Mr. Profeta: Correct.

Representative Harrison: Thank you Mr. Chair. This is a question for counsel. How does this relate to Representative Justice's bill in her early action plan is it in sink with that?

Mr. Givens: I think this is very similar to that, I think in both cases it requires state appropriations.

Mr. Profeta: If I could also respond. The Justice bill does have a provision to allow for carbon based payments (inaudible) adoption program, this is just a more concrete implementation of that concept.

Representative Hackney: Further discussion?

Representative Harrison: Are we talking about sludge out of lagoons?

Representative Hackney: No, that's not what this is. Further discussion, is there enough clarity to vote?

Dr. Boyles: On that note, I think it will be useful for the commission members to be able to see some of the details of these things in writing. With all due respect, if we can put this off until the next meeting. I think it is probably very valuable, I'm not quite sure I understand what is going on and it would be easier if I could read through it.

Representative Hackney: Alright, request to defer this one.

Mr. Shore: I'll try my hand at making this clear. That there is an acceptance by many that there will be some government subsidy of the conversion of hog farms to cleaner waste and waste technology and so the concept here is that some of that subsidy be tagged to how well new technologies reduce carbon emissions. So methane essentially, so new technologies that do very well reducing carbon emissions could get higher subsidies and new technologies that don't reduce carbon emissions would get lower subsidies and this is a precursor of what will happen with the carbon market place as the carbon market place becomes more robust, hog farmers will have the ability to sell their credits to the carbon market place. And I think this fund could help prime that carbon market place fund.

Mr. Profeta: Mr. Chairman I fully appreciate the need to see things in writing but I do have Commission (inaudible) that was submitted on January 31 and I've submitted actual language which I still (inaudible) on his computer. I can provide you with that right now. I voted on the (inaudible) CAPAG processes I don't have in writing but in faith and Representative Wilkins mandates that there will be a lot of debate going forward. But we have distributed and I can hand it to you right now for your consideration.

Dr. Riggs: Mr. Chairman I so move.

Representative Hackney: What is it you so move? I've heard about three different versions here. Alright, the version I think we are about to vote on is that there be a common agreement that some subsidy is necessary or desirable for conversion of hog farms with the lagoon technology to some other technology that consideration be given to carbon reduction as a reason for a higher priority in the subsidy process. Discussion, so many as favor of that motion please say

aye, oppose no. Alright, I believe the group is sinking lower by the passing five minutes.

Dr. Eggers: (Inaudible) and advocate for my own proposal with #17 – Net metering in North Carolina looks very different from other states and you did receive draft language on this from me as well. Just to kind of refresh you, you know North Carolina is one of the 39 states with net metering programs, 27 of the other states don't have any limits on cumulative capacity and are limited perhaps low or unnecessary. As well as it's very difficult for people to sign up for net metering, it requires not only quite a bit of time but potentially consultants and legal counsel is (inaudible) and far more (inaudible) than in other places. And we could (inaudible) is vague I would propose something rather specific but I think at the very least it would be good to request that the Utilities Commission quite sufficiently simplify the burden for signing up for net metering.

Representative Hackney: Alright the motion is that the Utilities Commission be requested to simplify net metering in North Carolina in order to encourage it's further and additional use or some such. Is that right? Discussion?

Mr. Urlaub: Thank you Mr. Chairman. Specifically the Utilities Commission, we have a net metering rule and we have an uncharacteristically strong limitation on the geographic presence of net metered systems or interconnected systems. It's 0.2 percent and I don't remember for the specific geographic area. But many states will go as high as one percent of let's say the electricity demands in an area. And if we wanted to make some kind of maybe helpful recommendation or direct it to the Utilities Commission it would be to allow a greater number of systems, a greater amount of renewable energy within a geographic area than they currently do under this tool, net metering.

Representative Hackney: Further discussion, if not so many as in favor of the motion please say aye, oppose no. The ayes appear to have it, the ayes do have it.

Dr. Smith: Chairman, I'm open to your recommendation on this. There are a suite of options within transportation that the transportation CAPAG was not able to get through or deal with fully. Not necessarily reflective of the fact that they aren't of value and I am curious whether we could make some sort of generic statement about recognizing that there are opportunities yet to be determined within the transportation sector that we want to continue to contemplate to be mindful of because there is sort of a void there. A couple of us have a couple of things on there, I'm not sure that it is appropriate at this point to do that, but I also think it maybe a noticeable gap it we don't at least acknowledge that in some way in the interim report and I'm open to suggestions on this.

Representative Hackney: Alright the motion is that the report includes a statement and a recognition that there are substantial reductions to be realized in

the transportation sector and that we do not yet have specific recommendations but that the Commission should continue to work on that. Words to that affect? Alright, that's the motion.

Representative Underhill: Thank you Mr. Chair. Are we discussing #16? Or is this just a general motion?

Representative Hackney: I don't know. No, #16 is much more specific than what we're doing, just a generic statement that we're going to work on that some more.

Representative Wilkins: Inquiry of the Chair. I got the inquire of my Chair and my Speaker at the same moment. It seems a little different but I am seeing that we've been extended to 2008. We've already turned out a good number of horses from the barn today, I'm wondering if we might not be wise to hold some of these for another day?

Representative Hackney: Well I think the motion is essentially to hold the transportation stuff for another day but to recognize that we ought to look at that more closely. That's basically the motion. So many as in favor of the motion please say aye, you're getting pretty weak, oppose no, the ayes have it. Pursuit to your statement Representative Wilkins do you have a motion?

Representative Wilkins: I would make a motion that we adjourn until that other day.

Representative Hackney: The motion is not debatable. I want to thank everybody for their work throughout this process. I've learned a tremendous amount from all of you, everyone has contributed, it's been a collaborative process, it has been an education process. Many of you I am sure have noticed that South Carolina is about to create a working committee on global climate change so our work is getting noticed I think and these recommendations to this General Assembly I think will receive some serious consideration as well. It's not debatable but you can get a question.

Dr. Riggs: When can we expect to meet again? Are we recessed until the end of the legislative session?

Representative Hackney: Everybody is going to want to see this report before it actually goes out under our name I assume Mr. Givens is that correct?

Mr. Givens: That's the pledge of the Commission. When the actual final interim product meet yourself coming back saying that, is together it will be distributed and we will either get everyone's approval or we will have a meeting to approve it and then we will be recessed until the session is over.

Representative Hackney: We're just authorized for this meeting so far but as Mr. Givens says that can change. Ok so many as in favor of the motion to adjourn please say aye, oppose no. Thank you very much.

Respectfully submitted,

_____
Joe Hackney, Co-chair

_____
Thelma T. Utley
Committee Clerk

VISITOR REGISTRATION SHEET

Global Climate — 2/22/07

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Global Climate — 2/22/07

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Lemuel W. Hinton	NCUC - Staff

Tom Peterson



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Memo

To:	North Carolina Legislative Commission on Global Climate Change
From:	The Center for Climate Strategies and North Carolina Department of Environment and Natural Resources
CC:	North Carolina Climate Action Plan Advisory Group and Technical Work Group Members
Subject:	Consideration of Recommendations for Inclusion in the LCGCC Interim Report
Date:	February 21, 2007

At the fifth meeting of the North Carolina Climate Action Plan Advisory Group (CAPAG) on January 24, 2007 16 draft pending greenhouse gas (GHG) mitigation options were approved unanimously (without objection) as final recommendations of the CAPAG out of a total of 53 draft pending options. The remaining 37 options not yet fully reviewed and approved by the CAPAG will be considered at its upcoming meetings in May, July and possibly the fall. The 16 approved CAPAG options are now available for consideration and approval as recommendations of the North Carolina Legislative Commission on Global Climate Change (Commission) to the General Assembly.

In addition, the Commission Chairs solicited additional suggested options from Commission members by January 31, 2007 to be considered as possible recommendations of the Commission. These suggestions are attached in Table 4 at the conclusion of this memo. Most of them are already incorporated in one or more of the 53 CAPAG mitigation options, but some may require additional analysis or design modification of CAPAG options, as noted.

The 16 current recommended mitigation options of the CAPAG include the following actions:

Residential, Commercial and Industrial (RCI):

- RCI-2, Expand Energy Efficiency Funds
- RCI-3, Energy Efficiency Requirements for Government Buildings
- RCI-4, Market Transformation and Technology Development Programs
- RCI-5, Improved Appliance and Equipment Efficiency Standards
- RCI-6, Building Energy Codes
- RCI-7, "Beyond Code" Building Design Incentives and Targets, Incorporating Local Building Materials and Advanced Construction

- RCI-8, Education (Consumer, Primary/Secondary, Post-Secondary/ Specialist, College and University Programs)
- RCI-11, Residential, Commercial, and Industrial Energy and Emissions Technical Assistance and Recommended Measure Implementation

Energy Supply (ES):

- ES-3, Removing Barriers to CHP and Clean DG
- ES-9, Incentives for CHP and Clean DG

Cross Cutting Issues (CC):

- CC-1, GHG Inventories and Forecasts
- CC-2, GHG Reporting
- CC-3, GHG Registry
- CC-4, Public Education and Outreach
- CC-5, Adaptation
- CC-6, Options for Goals or Targets (in support of the Commission)

Summary information on the 16 CAPAG options is attached at the end of this memo with the following information:

1) Tables 1-3 include results of analysis (for quantified options) and voting for RCI, ES and CC actions, as follows:
    a. GHG reduction potential,
    b. Costs or cost savings per ton GHG removed, and
    c. Level of CAPAG approval (unanimous for all 16 early consensus recommendations).
2) Mitigation Option Templates for the 16 CAPAG options includes summary text for RCI, ES and CC actions, as follows:
    a. Mitigation option description,
    b. Mitigation option design (goals, timing, coverage of parties), and
    c. Recommended implementation mechanism(s) and agencies as appropriate (the CAPAG was not prescriptive in some cases and instead identified potential approaches for further consideration).

In addition, an interim report to the Commission is available with summary information for all 53 CAPAG options as well as detailed technical appendices with full tables, templates and reference materials. This material includes estimates of the fully integrated, cumulative impact of all 53 CAPAG options on reduced GHG emissions in North Carolina. It also includes a summary table of recent suggested options by Commission members (Table 4 of this memo). These documents can be found on the CAPAG project website www.ncclimatechange.us at the following links:

- Interim Report to the Commission (19 pages)
  - http://www.ncclimatechange.us/ewebeditpro/items/O120F10930.pdf
- Technical Appendix 1: Residential, Commercial and Industrial Appendix, with Annexes
  - http://www.ncclimatechange.us/ewebeditpro/items/O120F10927.pdf
  - http://www.ncclimatechange.us/ewebeditpro/items/O120F10926.pdf
- Technical Appendix 2: Energy Supply Appendix, with Annex
  - http://www.ncclimatechange.us/ewebeditpro/items/O120F10925.pdf
  - http://www.ncclimatechange.us/ewebeditpro/items/O120F10924.pdf
- Technical Appendix 3: Transportation and Land Use Appendix
  - http://www.ncclimatechange.us/ewebeditpro/items/O120F10928.pdf
- Technical Appendix 4: Agriculture and Forestry Appendix
  - http://www.ncclimatechange.us/ewebeditpro/items/O120F10921.pdf
- Technical Appendix 5: Cross Cutting Issues Appendix, with Annex
  - http://www.ncclimatechange.us/ewebeditpro/items/O120F10923.pdf
  - http://www.ncclimatechange.us/ewebeditpro/items/O120F10922.pdf

Table 1.
Residential Commercial and Industrial Technical Work Group
Summary List of Mitigation Options

	Mitigation Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2007–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of CAPAG Support
		2010	2020	Total 2007-2020			
RCI-2	Expand Energy Efficiency Funds	1.5	8.2	55.8	-$1,346	-$24	Unanimous
RCI-3	Energy Efficiency Requirements for Government Buildings	0.0	1.7	9.6	-$130	-$14	Unanimous
RCI-4	Market Transformation and Technology Development Programs	0.0	2.1	10.7	-$339	-$32	Unanimous
RCI-5	Improved Appliance and Equipment Efficiency Standards	0.0	1.0	5.4	-$336	-$62	Unanimous
RCI-6	Building Energy Codes	0.6	4.4	28.7	-$490	-$17	Unanimous
RCI-7	"Beyond Code" Building Design Incentives and Targets, Incorporating Local Building Materials and Advanced Construction	0.5	2.9	20.4	-$293	-$14	Unanimous
RCI-8	Education (Consumer, Primary/Secondary, Post-Secondary/ Specialist, College and University Programs)	*Not quantified*					Unanimous
RCI-11	Residential, Commercial, and Industrial Energy and Emissions Technical Assistance and Recommended Measure Implementation	0.7	2.8	20.4	-$662	-$32	Unanimous

RCI-2 Expand Energy Efficiency Funds

Mitigation Option Description

Public (or systems) benefits charge is a fee assessed to utility customers based energy usage. A third party receives these funds to provide energy efficiency programming.

Mitigation Option Design

In order to support more energy efficiency/ renewable energy investments, it is recommended that:

1. North Carolina's existing Public Benefits Charge increase significantly.
2. NC Utilities Commission collect fees and provide oversight through administrators.
3. The Public Benefits Charge program maintain consistency in management and dedicated application of funds as a crucial design element.
4. The program make investments span a wide variety of residential, commercial and industrial applications.

Goals and Timing:

1.Re duce greenhouse gas emissions from RCI activities through public benefit charges.

2.Implem ent energy efficiency/ renewable energy programs comparable to more effective programs in other states.

3.One percent (1%) of utility revenues is an appropriate public benefits charge goal.

4.Thr ee year phase-in of public benefits charges.

5.Capital costs paid back through energy savings should reach payback in 12/15 yrs.

Parties Involved: Fee is collected from all customers of all utilities. Relevant stakeholder groups are involved in design, governance, oversight, management, and implementation of programs.

Implementation Mechanisms

Potential Implementing Mechanisms:

1. Incentives for consumers, retailer training, marketing, promotion, and education.
2. Fund Research and Development through contracts with private firms, universities, government labs, and private/public consortia.
3. Performance-based contracting for funding of energy efficiency improvements, with capital costs paid back through energy savings.
4. Establish a Reinvestment Fund:
   a. Providing financing for energy-efficiency efforts.
   b. Create infrastructure to deliver renewable technologies.
   c. State agencies keep the net savings or reinvest savings in energy-efficiency.
   d. Example: Pennsylvania "Energy Harvest" program.

Potential Implementing Agency: NC Utilities Commission and other agencies as the NCUC appoints/directs.

RCI-3 Energy Efficiency Requirements for Government Buildings

Mitigation Option Description

Governments should "lead by example": improve energy efficiency in all government buildings, set energy-efficiency goals for current buildings, new construction, and major renovations.

Mitigation Option Design

Elements of this Option Design include:

1. Adherence to energy-related guidelines in LEED+ standard.
2. Consolidate construction/maintenance budgets: energy efficiency is long-term savings.
3. Extend green campus initiatives to all public academic and government campuses.
4. Energy benchmarking, measurement, and tracking programs for government buildings.
5. Energy efficiency and renewable energy requirements for every government building.

Goals and Timing:

1. New construction/major renovations of government buildings meet LEED+ requirements.
2. Begin with all buildings entering the design phase by 2010.
3. Achieve 20% reduction from baseline 2002-03 energy consumption per gross square foot per year for all North Carolina existing government buildings by 2027.
4. In final year: new 5-year goal for government building energy efficiency improvement.
5. Build on current USI (Utility Savings Initiative) at North Carolina State Energy Office.

Parties Involved:

1. State agencies, UNC System and affiliates, Community College System, K-12 districts.
2. Local governments, building code enforcement, and other public entities.
3. Architects, building designers, engineers, developers, builders, contractors.
4. Regulators–State Construction, Energy, Budget and Management Offices.

Implementation Mechanisms

Potential Implementing Mechanisms:

1. Performance-based Contracting (PC): funding energy efficiency improvements.
2. Create information clearinghouse with software tools to calculate impact.
3. Energy technologies that should be promoted include but are not limited to:
   a. Solar technologies: photovoltaic panels, solar hot water heaters/air conditioning.
   b. Support for new-to-market technologies, such as Solar Hybrid Lighting.
   c. Ground-source Heat Pumps.
   d. Focus on end uses: motors, plug loads, networked computer management, etc.
4. Comprehensive statewide survey of energy/water efficiency in government buildings.

Potential Implementing Agency: State and other public agencies, coordinated by one agency or an oversight group as appropriate.

RCI-4 Market Transformation and Technology Development Programs

Mitigation Option Description

Market transformation work toward encouraging the bulk of the private market to adopt/incorporate technologies resulting in improved energy efficiency. As a result of market transformation programs, energy efficiency technologies and practices will be demanded by the public and chosen by builders and manufacturers, revolving around public/private review of quality/effectiveness, including partnerships between government agencies, retailers, manufacturers, and non-governmental agencies.

Mitigation Option Design

Ensure voluntary standards are rigorous enough, yet understandable and valuable to the buyer. Market transformation efforts go hand-in-hand with technology development efforts.

Market transformation and technology development program must be long-term and robust; to include consistent, enduring support, continued investment, and independent evaluation of the efficacy of the technologies.

This particular recommendation does not address a single technology or market, but is a method for bringing appropriate technologies and processes to the marketplace. Several technologies or approaches can be included, including encouraging the use of energy efficient motors and processes that recover waste from one process to use in other processes, increasing Energy Star funding/products use, and encouraging small purchasers to act in aggregate groups to reduce costs and quantify emission reduction benefits.

Goals:

1. Permanently transform markets to increase and accelerate uptake of products with higher energy efficiency and renewable energy products.
2. Provide consistent support with the end-result being a time when the support can be removed without the program benefits ending as well.

Timing: Set up agencies by 2010. Start activities in 2012.

Parties Involved: All sectors and stakeholders in the state may be involved, including retailers, utilities, manufacturers, non-profit consortia, consumers associations, professional associations (engineers, architects, builders, designers), and state agencies.

Implementation Mechanisms

Potential Implementing Mechanisms:

1. Collaborative marketing, funding R&D, patent protection, tax credits for R&D or new technologies, government procurement. Consider funding for State Energy Office.
2. Specific options to create necessary participation and buy-in: tax credits, low/no interest loans; financial incentives to business, industries and commercial firms to upgrade their equipment to more energy efficient technologies.

Potential Implementing Agency: Coordinating agency or agencies, which could be private or public, with participation by stakeholders noted above.

RCI-5 Improved Appliance and Equipment Efficiency Standards

Mitigation Option Description

Appliance efficiency standards reduce market cost of energy improvements by incorporating technological advances into base appliance models. Efficiency standards can be implemented at the state level, though implementation at a regional level is more efficient and preferred.

Mitigation Option Design

This mitigation option involves the replication of standards adopted in other states for appliances not covered by federal standards. Where technically feasible and economically justified, the State can work with other states in the region to advocate for stronger federal appliance efficiency standards. Implementation of stronger-than-federal standards together with other states in the Southeast region is preferred, as it provides a broader market for manufacturers and thus lowers net costs of higher-efficiency devices to North Carolina consumers.

Elements of this option design include:

1. Develop a committee/workgroup to develop recommendations on appliance standards.
2. Adopt State-level Appliance Efficiency Standards, to include commercial and information technology (IT) equipment.
3. The State voices support of more stringent federal-level appliance efficiency standards.
4. Design a standard for recycling of materials in appliances.
5. Include water use reduction as a criterion for appliance efficiency improvement.

Goals: Increase standards to level recommended by Appliance Standards Awareness Program.

Timing: Adopt new standards by 2010. Standards in force by 2012.

Parties Involved: State agencies to enforce state codes and standards.

Implementation Mechanisms

Potential Implementing Mechanisms:

1. Appliance Standards promulgated by legislation or developed administratively.
2. Reduce the higher-first-cost burden of higher-efficiency appliances by assisting low-income families with purchase of appliances meeting more stringent standards.
3. Elevated energy standards for appliances and equipment purchased by public agencies.
4. Work with manufacturers to consider impacts when setting new standards.

Potential Implementing Jurisdiction: State agencies to enforce state codes and standards.

RCI-6 Building Energy Codes

Mitigation Option Description

Building energy codes specify minimum energy efficiency levels for new buildings or existing buildings undergoing a major renovation. Energy use in North Carolina buildings accounts for one-third of North Carolina's current gross GHG emissions. Amending Building Codes to make strict energy efficiency requirements in buildings will significantly reduce GHG emissions.

Mitigation Option Design

International Energy Conservation Code 2000 is the model for North Carolina residential and commercial buildings. An ongoing process of code amendments is proposed as follows.

1. Adopt stringent codes to improve energy use in buildings. Use cost-effectiveness tests to identify where moving beyond national codes makes economic sense.
2. Adopt innovative features of advanced codes implemented in other states beyond current codes in force, including building systems codes (heating) and designs (lighting).
3. Improve statewide enforcement of existing and new building codes at all levels, and fully implement enforcement within 6 months of statewide code adoption.
4. Regularly update state energy codes in three-year cycle to coincide with national code.
5. Modify codes to remove obstacles to renewable energy use.
6. Include education for building inspectors and building industry professionals to assure the new codes are implemented and enforced.

Goals and Timing: Enforce existing building energy codes by 2008; establish a new energy code by 2010 that requires all buildings to be 20% more efficient than current national building energy codes. Update every 6 months when the national energy code changes.

Parties Involved:

1. North Carolina Department of Insurance to implement new codes.
2. State and Local government building code enforcement agencies.
3. Mobile Home Manufacturing Industry and Building Industry Associations.

Implementation Mechanisms

Potential Implementing Mechanisms:

1. Develop training and education for builders, contractors, trade schools, and Officials in Energy Enforcement.
2. Develop clearinghouse for information, including software tools to calculate impacts.

Potential Implementing Agency: North Carolina Department of Insurance, State and Local government building code enforcement agencies, Mobile Home Manufacturing Industry and Building Industry Associations

RCI-7 "Beyond Code" Building Design Incentives and Targets, Incorporating Local Building Materials and Advanced Construction

Mitigation Option Description

This option provides incentives and targets to induce the owners and developers of new and existing non-government buildings to markedly improve the efficiency of energy and resource use in those buildings, along with provisions for raising targets periodically and resources to help achieve the desired building performance.

Mitigation Option Design

Goals:

1. Promote and provide incentives for "beyond code" construction, using programs of various types for various sectors, such as:
2. Improved design and construction standards and guidelines addressing multiple aspects of resource conservation, with a focus on energy.
3. Promote the use of renewable energy technologies.
4. Provide incentives to induce 5% of new residential buildings and 2% of new commercial buildings annually to go to "beyond code" energy use levels that improve energy performance over the average new building (that meets the upgraded building code) by 30%.
5. Provide incentives to upgrade 20% of existing buildings by 2015 as follows:
   a. Increase residential building energy performance improvements by 15%.
   b. Increase commercial building energy performance improvements by 20%. This increase in efficiency should bring 20% of existing buildings up to the standard of the 2003 IECC (the current NC code, not the improved codes).

Timing: Begin program in 2007 and fully implement by 2012, except where noted otherwise.

Parties Involved: State and local governments, and other public entities. Building-code-enforcement practitioners.

Implementation Mechanisms

Potential Implementing Mechanisms: TBD

Potential Implementing Agency: Code enforcement agencies. Building professional trade groups. Community colleges. Universities. Primary/Secondary Schools. Public Information Agencies

RCI-8 Education (Consumer, Primary/Secondary, Post-Secondary/Specialist, College and University Programs)

Mitigation Option Description

The effectiveness of emissions reduction activities in many cases depends on providing information and education to consumers, as well as to future consumers (primary and secondary school students), regarding the energy and greenhouse gas emissions implications of consumer choices. In addition, specific and targeted education, outreach, and licensing requirements will be required for professionals in a variety of building-related trades.

Mitigation Option Design

Goals:

1. Training and education for builders and contractors in energy management and building code and other officials in energy code enforcement.
2. Continuing Education for building design and related professionals.
3. Energy-efficiency-related education introduced at community colleges and trade schools.
4. Consumer education programs.
5. Funding to the State Energy Office to support its role of providing consumer information.
6. Direct consumers to information and technologies for energy-efficiency and climate impacts reduction.
7. Introduce in School Curriculum.

Timing: TBD.

Parties Involved: Code enforcement agencies. Building professional trade groups. Community colleges. Universities. Primary/Secondary Schools. Public Information Agencies.

Implementation Mechanisms

Potential Implementing Mechanisms: TBD. Coverage of energy efficiency topics in the exam for general contractors and energy efficiency topics in continuing education and recertification course and exams for public school teachers.

Potential Implementing Agency: Code enforcement agencies. Building professional trade groups. Community colleges. Universities. Primary/Secondary Schools. Public Information Agencies.

RCI-11 Residential, Commercial, and Industrial Energy and Emissions Technical Assistance and Recommended Measure Implementation

Mitigation Option Description

This option provides incentives, expertise, information, and technical assistance to identify options to reduce fossil energy use and non-energy emissions of GHGs to the RCI sectors.

Mitigation Option Design

This initiative may include the following elements:

1. A residential energy audit program providing diagnostic testing and analysis that estimates energy use, energy cost savings, and reductions in emissions due to implementation of recommended measures.
2. A commercial energy audit program similar to the residential program that also considers alternative utility rate structures and load control opportunities.
3. An industrial energy audit program similar to the commercial program that also identifies key efficiency measures and opportunities for: capture and use of process heat, implementation of combined heat and power, and reducing the use of non-energy GHGs.
4. A Q&A and implementation follow-up mechanism.
5. Incentives and financial assistance to encourage implementation.

Goals: Annually, 10,000+ residential visits, 1,500+ commercial visits, and 300+ industrial visits. Over 50% of those to whom services are provided should implement at least 50% of the recommendations. The CAPAG recommended increasing this goal to 400,000 audits total.

Timing: An initial period of 3 years beginning in 2008, followed by an evaluation to determine whether or not to continue the program.

Parties Involved: Utilities, State Agencies, third-party efficiency providers, regulators, and others, such as a variety of stakeholders.

Implementation Mechanisms

Potential Implementing Mechanisms: TBD. Negotiated Emissions or Energy Savings Agreements. Participation in Voluntary Industry-Government Partnerships. Integration with Regional Demand Response Initiatives/recommendations.

Potential Implementing Agency: The State Energy Office can fund and/ or manage the effort or the Department of Environmental and Natural Resources could manage the program. The State Construction Office could conduct technical assistance and analysis of state facilities.

Table 2.
Energy Supply Technical Work Group
Summary List of Mitigation Options

	Mitigation Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2007–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of CAPAG Support
		2010	2020	Total 2007-2020			
ES-3	Removing Barriers to CHP and Clean DG	0.4	1.6	11.6	$66	$5.7	Unanimous
ES-9	Incentives for CHP and Clean DG	Combined with ES-3					Unanimous

ES-3 and ES-9 Removing Barriers and Providing Incentives to CHP and Clean Distributed Generation (DG)

Mitigation Option Description

Combined Heating Cooling and Power (CHP), also know as cogeneration, is a method of utilizing the thermal energy (heat) produced when generating electricity (power) in a single, coordinated process. CHP is more energy efficient than separate generation of electricity at a separate central electric plant and production of localized thermal energy for the end user. This distributed generation resource allows for recycling the heat, which is normally wasted to cooling towers or lakes at centralized electric generating stations, to meet onsite thermally driven demand such as process and space heating, cooling and dehumidification.

Mitigation Option Design

The proposed policy would encourage the adoption of CHP through a combination of regulatory improvements and expanded incentives designed to improve interconnection and net metering standards, adopt output based emission standards, and allow GHG friendly business arrangements, such as third party ownership of CHP based generation.

Goals: 50 percent of North Carolina's 4,000 MW of planned new electric generation will be CHP.

Timing: Goal should be achieved by 2018, within the time frame for new generation additions.

Parties involved: NC Utilities Commission, Utilities, NC Sustainable Energy Assoc.

Other: None Cited.

Implementation Mechanisms

Potential Implementing Mechanisms: This is a command and control policy that would be implemented with the following steps: 1) Encourage CHP systems of 20 MW or smaller (or of equivalent mechanical power) by a speedy adoption and customer friendly implementation of FERC Order 2006 Standardization of Small Generator Interconnection Agreements and Procedures, 2) Qualify recycled energy from CHP generation for existing renewable and energy efficiency incentive and loan programs, 3) Allow energy service companies to sell CHP and CDG output to third party customers, and 4) Facilitate governmental and non profit organizations to easily sell renewable energy credits and tax credits to the market place.

Potential Implementing Agencies: TBD

Table 3.
Cross Cutting Issues Technical Work Group
Summary List of Mitigation Options

	Mitigation Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2007–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of CAPAG Support
		2010	2020	Total 2007-2020			
CC-1	GHG Inventories and Forecasts	*Not Quantified*					Unanimous
CC-2	GHG Reporting	*Not Quantified*					Unanimous
CC-3	GHG Registry	*Not Quantified*					Unanimous
CC-4	Public Education and Outreach	*Not Quantified*					Unanimous
CC-5	Adaptation	*Not Quantified*					Unanimous
CC-6	Options for Goals or Targets (for CAPAG in support of COMMISSION)	*Not Quantified*					Unanimous

CC-1 GHG Inventories and Forecasts (I&F)

Mitigation Option Description

I&Fs elucidate the magnitude of all emission sources and sinks, the relative contribution of various emission sources and sinks to total emissions, and the factors that affect trends over time. Initially, the I&F will be used to inform state leaders and the public on statewide trends, opportunities for mitigating emissions or enhancing sinks, and verifying GHG reductions associated with implementation of North Carolina's Climate Action Plan.

Mitigation Option Design

Goals:

1. Periodically develop I&Fs with forecasts to reasonable and realistic future years (5 and 10 years), up to and including 2020.
2. Inventory of all emissions generated within the state as well as emissions associated with energy imported and consumed in the state.
3. Provide a projection that realistically forecasts future emissions based on expected growth and expected mitigation options.
4. Provide a basis for documenting reductions and credits "by difference" from year to year.

Timing: The program should be implemented as soon as possible. Reporting by major (Title V) point sources holding an air permit will begin for calendar year 2008. To be in agreement with routine EPA air emissions reporting requirements and regulations for other regulated air pollutants, the process for these and other sources should repeat as follows: every year for major point sources and every third year for other sources.

Parties Involved: The responsibility for preparing I&Fs should reside with the Division of Air Quality (DAQ). Other state agencies as well as private facilities (sources) will need to provide data to DAQ on a periodic basis.

Implementation Mechanisms

Potential Implementing Mechanisms:

1. The program should be integrated with existing DAQ I&F functions as committed to by DAQ in the September 2005 Report under the Clean Smokestacks Act.
2. An annual unofficial "difference" report should be issued for major point sources and include updates as available for other categories that are on an every-third-year rotation.
3. The state would develop I&Fs for area sources, small point sources, and mobile emissions.

Potential Implementing Agency: NC DAQ

CC-2 State Greenhouse Gas Reporting

Mitigation Option Description

GHG reporting reflects the measurement and reporting of GHG emissions at a statewide, sector, or sub-sector level to support tracking and management of emissions. It can help sources identify emission reduction opportunities and reduce risks associated with possible future GHG mandates by moving "up the learning curve" and helps in the construction of periodic state GHG inventories. Reporting is typically a precursor for participation in GHG reduction programs, opportunities for recognition, a GHG emission reduction registry, and securing "baseline protection."

Mitigation Option Design

Goals:

1. Encourage GHG mitigation activities from all quarters.
2. Phase in by sectors, with all entities reporting their GHG emissions and any emissions reduction programs they implement.
3. Applicable on a voluntary basis to all sources.
4. Reporting of GHG emissions on an organization-wide basis within North Carolina.
5. Occur annually on a calendar-year basis for all six traditional GHGs and, to the extent possible, for black carbon.
6. Verified through self-certification and NC DENR spot-checks. To qualify for future registry purposes, reports should undergo third-party verification.
7. Maximize consistency with federal, regional, and other states' GHG reporting programs and quantification protocols.
8. Reporting of direct emissions should be required; reporting of emissions associated with purchased power and heat should be phased in; and reporting of other indirect emissions should be allowed.
9. Reporting of emissions from GHG reduction projects should qualify for reporting.
10. Provide appropriate public transparency of reported emissions.

Timing: Implementation should begin as soon as possible.

Parties Involved: All entities that can verify ownership of GHG emissions.

Implementation Mechanisms

Potential Implementing Mechanisms: GHG reporting may be required by DAQ for some categories of sources through normal state rulemaking procedures. All else as per CC-1.

Potential Implementing Agency: NC DAQ

CC-3 State Greenhouse Gas Registry

Mitigation Option Description

A GHG registry enables uniform measurement and recording of GHG emissions reductions in a central repository. Typically, it also includes transaction ledger capability in order to support tracking, management, and ownership of emission reductions.

Mitigation Option Design

Goals:

1. Actively engage with other states in developing a regional or national GHG registry that will comprehensively meet the state's needs.
2. Cover all mitigation options the CAPAG recommends, provide adequate quality verification, and allow project-level reporting.
3. Participation should be voluntary, and costs should be borne primarily by participants.
4. Key elements include:
   a. Geographic applicability.
   b. Inclusion of as broad an array of sectors, sources, facilities, and approaches as possible.
   c. Start as far back chronologically as good data exists, as affirmed by third-party verification and allow registration of project-based reductions or "offsets" that are equally rigorously quantified.
   d. Incorporate adequate safeguards to ensure that reductions are not double-counted by multiple registry participants and provide appropriate transparency.
   e. Strive for maximum consistency with other state, regional, and/or national efforts; allow greatest flexibility as GHG mitigation approaches evolve; and provide guidance to assist participants.
   f. The state and its political subdivisions should be valid registry participants and should be allowed to participate in emission trading if and when such a program is developed and authorized. Revenues associated with the sale of any emission reduction credits generated by the state or its political subdivisions could be used to support the GHG emission inventory, forecasting, reporting, and registry functions within state government.

Timing: As soon as possible after a GHG reporting program is operating.

Parties Involved: All entities that can verify ownership of GHG emission reductions.

Implementation Mechanisms

Potential Implementing Mechanisms: Regional or national joint effort with other interested states, with subsequent operating costs shared by participants benefiting from the registry.

Potential Implementing Agency: NC DAQ

CC-4 State Climate Public Education and Outreach

Mitigation Option Description

Public education and outreach can support GHG emissions reduction efforts at the macro- or micro-scale level in relation to emissions reduction programs, policies, or goals. It is vital to fostering a broad awareness of climate change issues and effects (including co-benefits, such as clean air and public health) among the state's citizens and is necessary to engage citizens in actions to reduce GHG emissions.

Mitigation Option Design

Goals:

1. The state should "lead by example" in its own education and outreach activities by establishing a pro-active public education and outreach capability to assist in the implementation of CAPAG mitigation options adopted by the Governor.
2. Education and outreach activities would target five specific audiences:
   a. Policymakers and managers (e.g., legislators, regulators, executive branch, agencies, and employees);
   b. Educators and Students – by integrating climate change into primary and secondary educational curricula, post-secondary degree programs, and professional licensing programs;
   c. Community Leaders and Community-Based Organizations (e.g., institutions, municipalities, service clubs, social & affinity groups, non-governmental organizations, etc.);
   d. General Public – to increase awareness and engage citizens in climate actions in their personal and professional lives; and
   e. Industrial and Economic Sectors – in order to recognize leadership; share success stories and role models; and expand climate involvement and participation within the business community.

Timing: As rapidly as possible.

Parties Involved: NC DENR and many other key parties.

Implementation Mechanisms

Potential Implementing Mechanisms: Public education and outreach programs.

Potential Implementing Agency: NC DENR

CC-5 State Climate Change Adaptation Strategy

Mitigation Option Description

The state must develop a plan to manage the projected impacts of ongoing climate change.

Mitigation Option Design

Goals:

1. Create a state-sanctioned Blue Ribbon Commission on Adaptation to Climate Change (the Commission) to develop a state Climate Change Adaptation Plan (the Plan) to address the adaptation issues identified in the accompanying table.
2. The Plan should include at least the following:
   a. Comprehensive identification of potential climate change impacts.
   b. Recommended steps to respond to these impacts.
   c. Coordination of response efforts through state, local and federal agencies, organizations, etc.
   d. Establishment of time- and program-based goals.
   e. A benefit-cost analyses of the potential costs of a "status quo" approach as compared to implementing the Plan's recommendations.
   f. Prioritization of adaptation measures that also mitigate GHG emissions and recommendations based on the certainty and severity of adverse impacts to citizens, ecosystems and local economies.
   g. Periodic review and update of the Plan.
3. The state Legislature should provide funding to support development of and on-going revisions to the Plan.

Timing: The Commission should be established as soon as possible, and the Plan should be completed within one year of establishing the Commission. Parallel public education and outreach efforts regarding adaptation should commence immediately. "Early-adoption" opportunities should be addressed as rapidly as possible (even before the Commission is established, if possible), and pro-active adaptation initiatives should commence within the next 2-3 years.

Parties Involved: The Commission should involve and coordinate with all appropriate state and local agencies, organizations, institutions, and all affected sectors and interests.

Implementation Mechanisms

Potential Implementing Mechanisms: The Blue Ribbon Commission should be empanelled by the Governor and/or the Legislature.

Potential Implementing Agency: The Blue Ribbon Commission should stand alone from state agencies, but some staff assistance from NC DENR and/or other agencies may be necessary or desirable.

CC-6 Options for State Greenhouse Gas Goals or Targets

Mitigation Option Description

In response to a widely-anticipated cap on GHG emissions by the federal government, a number of states are currently establishing GHG caps. North Carolina should also establish voluntary goals to limit GHG emissions to prepare the state's economy for the likely caps at the national level and begin to sever the link between increasing energy demand and GHG emissions. \

Mitigation Option Design

Goals: The voluntary goal should be set to bring emissions back to a baseline, such as year 2000.

Timing: The goal should be set over a long-time horizon of 10-15 years to meet the baseline. It should be expressed as an interim goal on the longer path toward ultimate climate stabilization.

Parties Involved: This would be an overall voluntary goal for the State of North Carolina. There would be no mandates to any specific party. However, all sectors of the state's economy would have the opportunity to contribute toward meeting the state's goal.

Implementation Mechanisms

Potential Mechanisms: If recommended by the Commission, such a goal could be established by the General Assembly or by an executive order of the Governor.

Potential Implementing Agency: Multiple agencies could be involved in implementation, depending on actions undertaken as a part of a plan to reach the goals.

Table 4. NC Commission Member Additional Options

Suggestion #	GHG Mitigation Action	Notes	Recommended By
1)	Renewable Portfolio Standard combined with Energy Efficiency Standards amounting to a 20% Energy Supply and Offset Mix (REPS) by the year 2020	Under consideration by the CAPAG, and will require some additional analysis. This is generally consistent with RCI-1 and RCI-2, though we will need to consider the need for aligning the goals of ES-2 with RCI options (which we would have had to do anyway. Linked to several AFW options covering animal waste to methane energy, landfill gas to energy, agricultural waste to energy, forestry biomass to energy. Note linkage to feedstock supplies for this option coming out of AFW-5, 9, 10 and 11.	Toben, Shore
2)	Increase funding to the Forest Development Program (FDP) by $5 million.	Under consideration by the CAPAG and appears to be covered under the AFW's forestry options (AFW8-10).	Slocum
3)	Increase Allowable Tractor-Trailer Truck Weights on state roads to 90,000 lbs., for units with 6th axle.	Not under direct consideration by the CAPAG and will require additional analysis.	Slocum
4)	Increase Funding for Agricultural Development and Farmland Preservation Trust Fund; provide at least $40 million annually. Through some funding mechanism (or combination of mechanisms), provide at least $40 million annually to the Agricultural Development and Farmland Preservation Trust Fund to support long-term conservation of our farm and forest land resources:	Under consideration by the CAPAG and covered under AFW-4 and 7.	Slocum
5)	Expand Allowable Range of Forest Biomass Under the NC Green Power. Expand the NC Green Power program to include all available sources and not just a very limited subset of forest biomass: C	Under consideration by the CAPAG under RCI-9 and covered under AFW-9&10.	Slocum

6)	Remove the barriers that prevent start-up and retrofit/adaptive operations of government, commercial, industrial and institutional cogeneration and tri-generation plants throughout North Carolina.	Under consideration by the CAPAG. Covered in general in the mitigation option design and implementation measures in RCI-10, but could be included in slightly more detail. No particular impacts on modeling.	Cowell
7)	Remove barriers preventing micro-cogeneration at the household and small-business level.	Under consideration by the CAPAG, and will require additional analysis. Covered in general in the mitigation option design and implementation measures in RCI-10, but could be included in slightly more detail. No particular impacts on modeling. Covered also in the mitigation option design and implementation measures in ES-3 and ES-9. The effect of the second would need to be incorporated into ES analysis after RCI consideration.	Cowell
8)	Management of Hog Manure.	Under consideration by the CAPAG under AFW-1 (anaerobic digesters and energy utilization). This has a direct link with ES-1 and ES-2.	Profeta
9)	Consider the Biofuels Group Recommendations.	Under consideration by the CAPAG. Covered under the AFW ethanol and biodiesel options.	Peele, Shore
10)	Fund NC Farm Bureau, NC GreenPower	Under consideration by the CAPAG under ES and AFW options.	Peele
11)	Revolving Loan Fund for Green School Construction.	Not under consideration by the CAPAG, and will require additional analysis. Suggests a "Revolving Loan Fund for Green School Construction", which could fairly easily be added as an implementation measure for RCI-3 (which also could be more explicit in its application to schools).	Garrou
12)	5% RPS with Other Energy Conservation Measures.	Under consideration by the CAPAG. Tangential relation to RCI options, as it recommends biomass power generation, which is a part of RCI-10 (so no additional work required, some assumptions could be changed).	Clark
13)	Encourage Development of "Low Hanging Fruit" Renewable	Under consideration by the CAPAG under various ES, TLU and AFW	Clark

	Options.	options.	
14)	Voluntary and incentive-based activities and programs suggested by other member of the Legislative Commission could be implemented to determine their impact.	Under consideration by the CAPAG under various options.	Everett, Choi
15)	CO2 equivalent emissions reduction. Draft bill that directs the State to design an emissions reduction program by 2010, and sets the goals reduce emissions (from what level?) by 60% by 2025, and 80% by 2050.	Generally consistent with what we have so far in terms of overall reduction potential from the 53 options as currently configured, but would require additional analysis to go beyond 2020 to the 2025 time period.	Eggers
16)	Draft bill directing NC DOT to make plans public, consider and analyze climate impacts of plans.	TLU-1a focuses more on local growth plans; although there is some overlap, this recommendation would best be seen as a useful complement to TLU-1a. Linkage to AFW-4 and AFW-7 (Ag and Forestry land protection measures). Could be mentioned as implementation measures/goals in RCI-7 and RCI-8.	Families Together
17)	Draft bill to change NC net metering regulations to allow more use, streamline regulations.	Covered and included, in a more general way than the bill, in the mitigation option design and implementation measures in RCI-10.	Eggers
18)	This list of options prepared by environmental NGOs includes several that overlap with RCI, ES, TLU and AFW options.	Generally covered but may require additional analysis. The REPS option includes energy efficiency, and mentions a range of target investment (as a fraction of utility revenue). It also includes a specific target for a combination of solar hot water and solar PV. Several education options are mentioned. In general, most of the options included here appear in some form in RCI, but some could be made more explicit as parts of goals or implementation measures within RCI option write-ups. In particular, a goal is cited for State Lead by Example, that isn't really explicit enough (as to whether it applies to new and/or existing buildings, and as to the scope of what "government"	Shore, Smith, Stephenson, and Urlaub

		includes) to know whether the existing RCI-3 goal is consistent with it.	
19)	Fuel Savings Measures (idle reduction)	Covered: TLU-4, Truck Stop Electrification, and TLU-8, Anti-Idling.	Shore, Smith, Stephenson, and Urlaub
20)	Appropriate funds for research and development of microalgae for fuel.	Covered: algal oil feedstock for biodiesel production is recognized within AFW-2, as an example of new feedstock source needed to meet the in-state production targets. We assume that the R&D addressed in this bill ($500k/yr) would be covered within the incentives estimated to be needed to promote production to achieve the targets for AFW-2 (discounted costs range from $5MM-$33MM/yr).	Eggers
21)	Incentives for Carbon Reduction Technologies in Agricultural Sector, including bio char.	Covered under AFW-1.	Smith, Shore
22)	Formulation of a climate adaptation strategy for North Carolina.	Covered under CC-5.	Riggs, Stephenson and Clark
23)	More analysis of options is needed under Section 5 of the COMMISSION	Costs and GHG reduction benefits for options have been calculated to the specifications of the CAPAG and its TWGs, as reflected in the mitigation option templates and reference materials. Additional analysis of costs and secondary economic impacts and other co-benefits is possible, depending on need. GHG reductions from specific actions are cumulative in their contribution toward reduced global GHG atmospheric concentrations. Results of reduced GHG concentrations have been established by the Intergovernmental Panel on Climate Change (IPCC) and affirmed by the US National Academies of Science (NAS).	Everett, Choi, Howard, and Slocum

General Assembly of North Carolina

LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE

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AGENDA

2:00 p.m. Thursday 22 February 2007
Room 643 Legislative Office Building

1. Call to order
   Representative Joe Hackney, Presiding

2. Introductory remarks by Co-Chairs
   Representative Joe Hackney
   John. L. W. Garrou

3. Report to the Commission and explanation of agenda items
   George F. Givens, Commission Counsel

4. Consideration of recommendations for inclusion in the Interim Report
   Brock Nicholson, Deputy Director
   Division of Air Quality, Department of Environment and Natural Resources

   Tom Peterson, Executive Director
   Center for Climate Strategies

   Members of the Commission

5. Introduction of visiting Members of the House of Commons in London
(Michael Ancram, Q.C.M.P.; Charles Hendry, M.P.; Peter Kilfoyle, M.P.; and Bill Olner, M.P.)
Remarks
The Right Honorable Michael Ancram, Q.C.M.P.

Martin Rickerd, O.B.E., M.V.O.
Her Majesty's Consul General

6. Consideration of the draft Interim Report

7. Commission discussion and announcements

8. Adjourn

COMMISSION WEBSITE:

In order to provide public access to the materials distributed at the meetings of the Commission and other documents related to the Commission, a website has been developed. The website can be viewed online at the following address:

http://www.ncleg.net/gascripts/DocumentSites/browseDocSite.asp?nID=14

ADDITIONAL INFORMATION:

Persons having questions about the Commission meeting or other matters related to the Commission may contact Commission Counsel or other Commission staff at (919) 733-2578.

LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE

INTERIM REPORT TO THE ENVIRONMENTAL REVIEW COMMISSION AND THE GENERAL ASSEMBLY OF NORTH CAROLINA

2007 REGULAR SESSION

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Memo

To:	North Carolina Legislative Commission on Global Climate Change
From:	The Center for Climate Strategies and North Carolina Department of Environment and Natural Resources
CC:	North Carolina Climate Action Plan Advisory Group and Technical Work Group Members
Subject:	Interim Report to the North Carolina Legislative Commission on Global Climate Change and Current Status of CAPAG Recommendations
Date:	February 20, 2007

Background

The North Carolina Climate Action Plan Advisory Group (CAPAG) process was created to provide comprehensive recommendations for a state climate action plan to the North Carolina Department of Environment and Natural Resources (DENR). It is structured to be complementary to the North Carolina Legislative Commission on Global Climate Change (Commission) as this body considers economic opportunities for action to reduce state greenhouse gas (GHG) emissions.

The CAPAG and Commission processes are integrated in a number of ways to accomplish these joint objectives:

- A number of Commission members serve as CAPAG members.
- The CAPAG has received feedback from Commission members regularly in the course of its deliberations since February of 2006.
- DENR and the Center for Climate Strategies (CCS) have provided regular issue briefings and progress reports to the Commission since its startup during the same period.
- Most importantly, the CAPAG process has served as the primary mechanism for identifying and analyzing potential mitigation options and economic opportunities for both DENR and the Commission.

In formulating mitigation options for consideration as final recommendations, the CAPAG has relied extensively on joint fact-finding and policy development assistance from CAPAG

members and other participants in five sector based Technical Work Groups (TWGs) that cover the following economic sectors:

- Energy Supply (ES), including heat and power generation;
- Residential, Commercial and Industrial (RCI), including stationary source energy demand and process emissions);
- Transportation and Land Use (TLU);
- Agriculture, Forestry and Waste Management (AFW); and
- Cross Cutting Issues (CC), including emissions reporting, registries, education, adaptation and goals.

Current Progress

At present, the CAPAG has developed a total of 53 draft GHG mitigation options as potential state climate action plan recommendations, including 16 "early consensus" actions approved at its last meeting (below). The full set of 53 CAPAG mitigation options include a variety of actions that could be implemented by administrative and or legislative means, depending on the measure. They were derived from an initial list of over 300 possible state actions across all economic sectors identified by the CAPAG with facilitative and technical assistance from CCS, in coordination with DENR, based on existing and planned actions in North Carolina and other states. The CAPAG has met five times in person and the TWGs have held 54 teleconference calls and or in person meetings. At least two additional meetings of the CAPAG are scheduled along with additional TWG meetings to continue the process of finalizing recommendations for a final report.

At its fifth meeting on January 24, 2007, the CAPAG began the process of approving draft mitigation options. A total of 52 options were presented, including detailed review of 26 options that had received full TWG review. Of these 26 fully reviewed draft mitigation options, 16 were approved as final recommendations through early consensus of the CAPAG, subject to additional clean up and revision of text and analysis. A number of questions and suggested changes were identified for options reviewed but not approved at this meeting. In addition, CCS has developed new analysis for subsequent review for several options not fully reviewed at the last CAPAG meeting, including those in Transportation and Land Use, and Agriculture, Forestry and Waste TWGs. Two new options were added to the list of "priority for analysis" options of the CAPAG, one of which (urban forestry) has been designated as a new stand alone option and the other (organic farming) as a component of an existing option (soil carbon buildup). Additional analysis of secondary economic impacts, including jobs, is planned for a set of options to be determined by the CAPAG.

Early Consensus CAPAG Recommendations

Early consensus actions of the CAPAG were identified through formal group vote at its fifth meeting on January 24, 2007. Draft mitigation options that received no objections to adoption during voting by the CAPAG are considered final recommendations, and are also referred to as early consensus options. Additional rounds of voting to determine consensus levels for will occur on remaining options. Additional details on this early set of final CAPAG recommendations are

included in the attached summary tables and supplemental policy templates. This current list of 16 final CAPAG recommendations includes the following actions:

Residential, Commercial and Industrial:

- RCI-2, Expand Energy Efficiency Funds
- RCI-3, Energy Efficiency Requirements for Government Buildings
- RCI-4, Market Transformation and Technology Development Programs
- RCI-5, Improved Appliance and Equipment Efficiency Standards
- RCI-6, Building Energy Codes
- RCI-7, "Beyond Code" Building Design Incentives and Targets, Incorporating Local Building Materials and Advanced Construction
- RCI-8, Education (Consumer, Primary/Secondary, Post-Secondary/ Specialist, College and University Programs)
- RCI-11, Residential, Commercial, and Industrial Energy and Emissions Technical Assistance and Recommended Measure Implementation

Energy Supply:

- ES-3, Removing Barriers to CHP and Clean DG
- ES-9, Incentives for CHP and Clean DG

Cross Cutting Issues:

- CC-1, GHG Inventories and Forecasts
- CC-2, GHG Reporting
- CC-3, GHG Registry
- CC-4, Public Education and Outreach
- CC-5, Adaptation
- CC-6, Options for Goals or Targets (for CAPAG in support of LCGCC)

Draft CAPAG Mitigation Options Still Under Consideration

The remaining 37 draft pending CAPAG mitigation options (not yet approved) will be considered and voted on by members at upcoming CAPAG meetings in May, July and possibly the fall. As a result, the list and results of analysis for mitigation options that are still pending and contained in this interim report should be considered draft.

Draft pending CAPAG mitigation options are listed below:

Residential, Commercial and Industrial:

- RCI-1, Demand Side Management Programs for the Residential, Commercial and Industrial Sectors

a. Alternative Case 1: Mid-Range EE Investment

b. Alternative Case 2: High-Range EE Investment

- RCI-9 Green Power Purchasing (required for state facilities) and Bulk Purchasing Programs for Energy Efficiency or Other Equipment
- RCI-10, Distributed Renewable and Clean Fossil Fuel Power Generation

Energy Supply:

- ES-1, Renewable Energy Incentives
- ES-2, Environmental Portfolio Standard
- ES-4, CO2 Tax and/or Cap-and-Trade
- ES-5, Legislative Changes to Address Environmental & Other Factors
- ES-6, Incentives for Advanced Coal
- ES-7, Public Benefit Charge
- ES-8, Waste to Energy
- ES-10, NC Greenpower Renewable Resources Program

Transportation and Land Use:

- TLU-1a, Land Development Planning
- TLU-1b, Multi-modal Transportation & Promotion
- TLU-3a, Feebates to raise revenue
- TLU-3a, Feebates to change fleet mix
- TLU-4, Truck-stop Electrification
- TLU-5, Tailpipe GHG Standards
- TLU-6, Biofuels Bundle
- TLU-7, Procure Efficient Fleets
- TLU-8, Anti-idling
- TLU-9, Diesel Retrofits
- TLU-10a, Fuel tax incentives (50 cents/gallon)
- TLU-10b, Fuel tax incentives (10 cents/gallon)
- TLU-11, Pay As You Drive Insurance
- TLU-12, Incentives for Advanced Tech Vehicles

Agriculture, Forestry and Waste:

- AFW-1, Manure Digesters & Energy Utilization
- AFW-2, Biodiesel Production (incentives for feedstocks and production plants)

- AFW-3, Soil Carbon Management (including organic farming incentives)
- AFW-4, Preserve Agricultural Land
- AFW-5, Agricultural Biomass Feedstocks for Electricity or Steam Production
- AFW-6, Policies to Promote Ethanol Production
- AFW-7, Forest Protection – Reduced Clearing and Conversion to Nonforest Cover
- AFW-8, Afforestation and/or Restoration of Nonforested Lands
- AFW-9&10, Expanded Use of Forest Biomass and Better Forest Management
- AFW-11, Landfill Methane and Biogas Energy Programs
- AFW-12, Increased Recycling Infrastructure and Collection
- AFW-13, Urban Forestry Measures

The full list of 53 CAPAG options are summarized in detailed tables at the end of this memo (Tables 3-7), including analysis of estimated GHG reduction potential, and costs or cost savings for each option. In addition, detailed mitigation option templates and supporting reference materials are contained in technical appendices to this memo for all 53 mitigation options for each of the five TWGs. These are posted to the project website as follows:

- Technical Appendix 1: Residential, Commercial and Industrial Appendix, with Annexes
  - http://www.ncclimatechange.us/ewebeditpro/items/O120F10927.pdf
  - http://www.ncclimatechange.us/ewebeditpro/items/O120F10926.pdf
- Technical Appendix 2: Energy Supply Appendix, with Annex
  - http://www.ncclimatechange.us/ewebeditpro/items/O120F10925.pdf
  - http://www.ncclimatechange.us/ewebeditpro/items/O120F10924.pdf
- Technical Appendix 3: Transportation and Land Use Appendix
  - http://www.ncclimatechange.us/ewebeditpro/items/O120F10928.pdf
- Technical Appendix 4: Agriculture and Forestry Appendix
  - http://www.ncclimatechange.us/ewebeditpro/items/O120F10921.pdf
- Technical Appendix 5: Cross Cutting Issues Appendix, with Annex
  - http://www.ncclimatechange.us/ewebeditpro/items/O120F10923.pdf
  - http://www.ncclimatechange.us/ewebeditpro/items/O120F10922.pdf

For a quick read of mitigation options, Commission members should particularly focus on the following key elements of these mitigation option templates:

- Option description,
- Option design (goals, timing, coverage of parties), and
- Implementation mechanism(s)

Additional Recommendations by Commission Members

Several recommendations for early action were submitted by individual members of the Commission to the Commission Chairs on January 31, 2007 and are summarized in Table 2. Most of these suggested mitigation options are already included in the design and or analysis of the 53 CAPAG mitigation options (as noted in Table 2), but some may require additional design components or analysis by the CAPAG. CCS looks forward to working closely with the Commission to provide additional support for the evaluation of these suggestions by Commission members, as needed.

Table 1. NC LCGCC Member Additional Options

Suggestion #	GHG Mitigation Action	Notes	Recommended By
1)	Renewable Portfolio Standard combined with Energy Efficiency Standards amounting to a 20% Energy Supply and Offset Mix (REPS) by the year 2020	Under consideration by the CAPAG, and will require some additional analysis. This is generally consistent with RCI-1 and RCI-2, though we will need to consider the need for aligning the goals of ES-2 with RCI options (which we would have had to do anyway. Linked to several AFW options covering animal waste to methane energy, landfill gas to energy, agricultural waste to energy, forestry biomass to energy. Note linkage to feedstock supplies for this option coming out of AFW-5, 9, 10 and 11.	Toben, Shore
2)	Increase funding to the Forest Development Program (FDP) by $5 million.	Under consideration by the CAPAG and appears to be covered under the AFW's forestry options (AFW8-10).	Slocum
3)	Increase Allowable Tractor-Trailer Truck Weights on state roads to 90,000 lbs., for units with 6th axle.	Not under direct consideration by the CAPAG and will require additional analysis.	Slocum
4)	Increase Funding for Agricultural Development and Farmland Preservation Trust Fund; provide at least $40 million annually. Through some funding mechanism (or combination of mechanisms), provide at least $40 million annually to the Agricultural Development and Farmland Preservation Trust	Under consideration by the CAPAG and covered under AFW-4 and 7.	Slocum

	Fund to support long-term conservation of our farm and forest land resources:		
5)	Expand Allowable Range of Forest Biomass Under the NC Green Power. Expand the NC Green Power program to include all available sources and not just a very limited subset of forest biomass: C	Under consideration by the CAPAG under RCI-9 and covered under AFW-9&10.	Slocum
6)	Remove the barriers that prevent start-up and retrofit/adaptive operations of government, commercial, industrial and institutional cogeneration and tri-generation plants throughout North Carolina.	Under consideration by the CAPAG. Covered in general in the mitigation option design and implementation measures in RCI-10, but could be included in slightly more detail. No particular impacts on modeling.	Cowell
7)	Remove barriers preventing micro-cogeneration at the household and small-business level.	Under consideration by the CAPAG, and will require additional analysis. Covered in general in the mitigation option design and implementation measures in RCI-10, but could be included in slightly more detail. No particular impacts on modeling. Covered also in the mitigation option design and implementation measures in ES-3 and ES-9. The effect of the second would need to be incorporated into ES analysis after RCI consideration.	Cowell
8)	Management of Hog Manure.	Under consideration by the CAPAG under AFW-1 (anaerobic digesters and energy utilization). This has a direct link with ES-1 and ES-2.	Profeta
9)	Consider the Biofuels Group Recommendations.	Under consideration by the CAPAG. Covered under the AFW ethanol and biodiesel options.	Peele, Shore
10)	Fund NC Farm Bureau, NC GreenPower	Under consideration by the CAPAG under ES and AFW options.	Peele
11)	Revolving Loan Fund for Green School Construction.	Not under consideration by the CAPAG, and will require additional analysis. Suggests a "Revolving Loan Fund for Green School Construction", which could fairly easily be added as an implementation measure for RCI-3 (which also could be more explicit in its application to	Garrou

		schools).	
12)	5% RPS with Other Energy Conservation Measures.	Under consideration by the CAPAG. Tangential relation to RCI options, as it recommends biomass power generation, which is a part of RCI-10 (so no additional work required, some assumptions could be changed).	Clark
13)	Encourage Development of "Low Hanging Fruit" Renewable Options.	Under consideration by the CAPAG under various ES, TLU and AFW options.	Clark
14)	Voluntary and incentive-based activities and programs suggested by other member of the Legislative Commission could be implemented to determine their impact.	Under consideration by the CAPAG under various options.	Everett, Choi
15)	CO2 equivalent emissions reduction. Draft bill that directs the State to design an emissions reduction program by 2010, and sets the goals reduce emissions (from what level?) by 60% by 2025, and 80% by 2050.	Generally consistent with what we have so far in terms of overall reduction potential from the 53 options as currently configured, but would require additional analysis to go beyond 2020 to the 2025 time period.	Eggers
16)	Draft bill directing NC DOT to make plans public, consider and analyze climate impacts of plans.	TLU-1a focuses more on local growth plans; although there is some overlap, this recommendation would best be seen as a useful complement to TLU-1a. Linkage to AFW-4 and AFW-7 (Ag and Forestry land protection measures). Could be mentioned as implementation measures/goals in RCI-7 and RCI-8.	Families Together
17)	Draft bill to change NC net metering regulations to allow more use, streamline regulations.	Covered and included, in a more general way than the bill, in the mitigation option design and implementation measures in RCI-10.	Eggers
18)	This list of options prepared by environmental NGOs includes several that overlap with RCI, ES, TLU and AFW options.	Generally covered but may require additional analysis. The REPS option includes energy efficiency, and mentions a range of target investment (as a fraction of utility revenue). It also includes a specific target for a combination of solar hot water and solar PV. Several education options are mentioned. In	Shore, Smith, Stephenson, and Urlaub

		general, most of the options included here appear in some form in RCI, but some could be made more explicit as parts of goals or implementation measures within RCI option write-ups. In particular, a goal is cited for State Lead by Example, that isn't really explicit enough (as to whether it applies to new and/or existing buildings, and as to the scope of what "government" includes) to know whether the existing RCI-3 goal is consistent with it.	
19)	Fuel Savings Measures (idle reduction)	Covered: TLU-4, Truck Stop Electrification, and TLU-8, Anti-Idling.	Shore, Smith, Stephenson, and Urlaub
20)	Appropriate funds for research and development of microalgae for fuel.	Covered: algal oil feedstock for biodiesel production is recognized within AFW-2, as an example of new feedstock source needed to meet the in-state production targets. We assume that the R&D addressed in this bill ($500k/yr) would be covered within the incentives estimated to be needed to promote production to achieve the targets for AFW-2 (discounted costs range from $5MM-$33MM/yr).	Eggers
21)	Incentives for Carbon Reduction Technologies in Agricultural Sector, including bio char.	Covered under AFW-1.	Smith, Shore
22)	Formulation of a climate adaptation strategy for North Carolina.	Covered under CC-5.	Riggs, Stephenson and Clark
23)	More analysis of options is needed under Section 5 of the LCGCC	Costs and GHG reduction benefits for options have been calculated to the specifications of the CAPAG and its TWGs, as reflected in the mitigation option templates and reference materials. Additional analysis of costs and secondary economic impacts and other co-benefits is possible, depending on need. GHG reductions from specific actions are cumulative in their contribution toward reduced global GHG atmospheric concentrations. Results of reduced GHG	Pittenger, Everett, Choi, Howard, and Slocum

		concentrations have been established by the Intergovernmental Panel on Climate Change (IPCC) and affirmed by the US National Academies of Science (NAS).	

Cumulative Results of CAPAG Options

Climate mitigation action plans support implementation of a number of programs jointly over time. As a result, the overall potential effectiveness of a plan requires analysis of the combined or cumulative impact of the actions. The cumulative impacts of implementing all 53 of the CAPAG mitigation options were calculated by CCS by integrating of the stand alone results for each of the options (reported in the policy templates and attached summary tables) to remove double counting and adjust for supply and demand and other interactions between potentially overlapping measures. Because many options overlap in some fashion, the cumulative impact of all options combined is substantially less than the simple addition of individual options.

Table 3 provides a summary the potential cumulative impacts of all 53 CAPAG mitigation options, if implemented, in comparison to reference case emissions projections for North Carolina. These data have not been reviewed by the CAPAG or TWGs and should be considered preliminary draft estimates. Projected North Carolina reference case emissions are provided from the latest draft of the North Carolina GHG Emissions Inventory and Forecast (a full draft of this report is posted to the project website) using four separate GHG accounting approaches:

- Consumption Net (activities of associated with energy and materials consumed in state, and including carbon sequestration)
- Consumption Gross (activities of associated with energy and materials consumed in state, not including carbon sequestration)
- Production Net (activities of associated with energy and materials produced in state, and including carbon sequestration)
- Production Gross (activities of associated with energy and materials produced in state, not including carbon sequestration)

A comparison of reference case emissions and the potential results of CAPAG actions are also summarized in Figure 1 using a *net consumption* based system, the standard accounting system used by states for GHG mitigation.

Preliminary draft analysis of state emissions reductions from CAPAG options show that projected state emissions in 2020 would be 49 percent lower with action than without action.

These findings assume that all options would be fully implemented, and that future reference case emissions would not be higher than current estimates in the draft North Carolina GHG inventory and forecast. Quantification of costs or cost savings has been completed for most of the 53 mitigation options, but some have not yet been reviewed by the CAPAG. As a result, CCS has not yet assembled an aggregate net cost analysis of the 53 CAPAG mitigation options.

Table 2. North Carolina Emissions Projections (MMTCO2e) With and Without Action

Consumption Basis Net	**1990**	**2000**	**2010**	**2020**
Projected NC Reference Case GHG Emissions	115.4	159.8	198.0	241.1
Current Estimates of Total CAPAG GHG Reductions			27.24	117.46
Projected Emissions After CAPAG Reductions			170.8	123.7
Consumption Basis Gross	**1990**	**2000**	**2010**	**2020**
Projected NC Reference Case GHG Emissions	138.5	183.5	221.8	264.9
Current Estimates of Total CAPAG GHG Reductions			27.24	117.46
Projected Emissions After CAPAG Reductions			194.5	147.4
Production Basis Net	**1990**	**2000**	**2010**	**2020**
Projected NC Reference Case GHG Emissions	107.8	153.9	190.0	231.1
Current Estimates of Total CAPAG GHG Reductions			27.24	117.46
Projected Emissions After CAPAG Reductions			162.8	113.7
Production Basis Gross	**1990**	**2000**	**2010**	**2020**
Projected NC Reference Case GHG Emissions	131.0	177.6	213.8	254.9
Current Estimates of Total CAPAG GHG Reductions			27.24	117.46
Projected Emissions After CAPAG Reductions			186.5	137.4

Figure 1. North Carolina Emissions Projections (MMTCO2e) With and Without Action

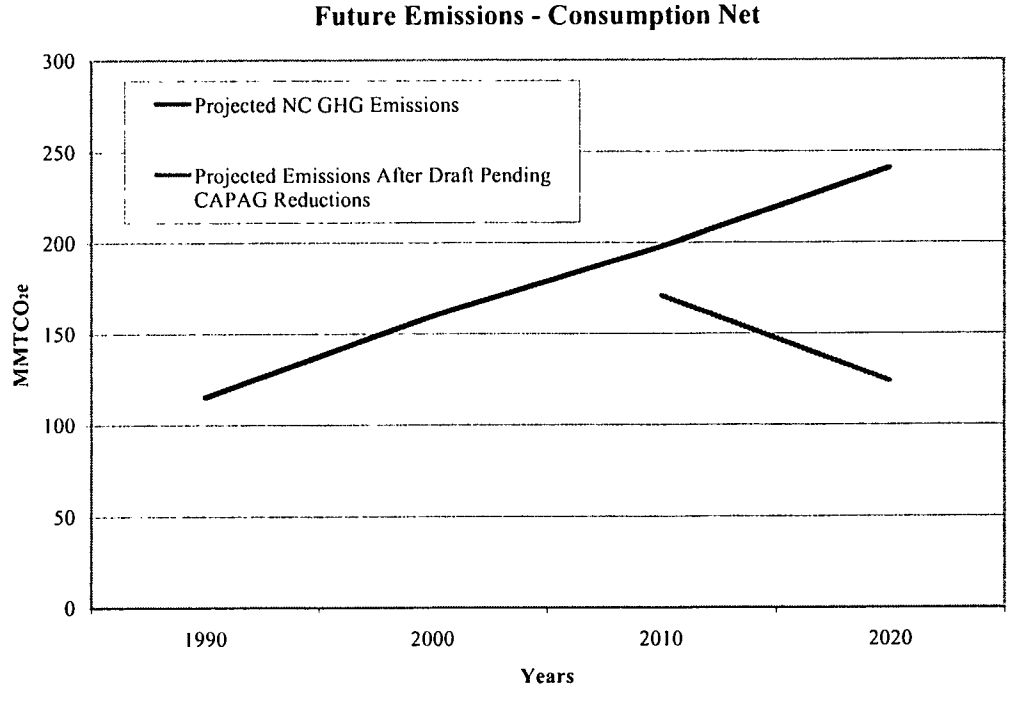


Table 3.
Residential, Commercial and Industrial Technical Work Group
Summary List of Mitigation Options

	Mitigation Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2007–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Status of Option
		2010	2020	Total 2007-2020			
RCI-1	Demand Side Management Programs for the Residential, Commercial and Industrial Sectors						
	--Alternative Case 1: Mid-Range EE Investment	0.6	3.9	26.1	-$631	-$24	Pending
	--Alternative Case 2: High-Range EE Investment	3.0	18.3	121.4	-$2,927	-$24	Pending
RCI-2	Expand Energy Efficiency Funds	1.5	8.2	55.8	-$1,346	-$24	Completed
RCI-3	Energy Efficiency Requirements for Government Buildings	0.0	1.7	9.6	-$130	-$14	Completed
RCI-4	Market Transformation and Technology Development Programs	0.0	2.1	10.7	-$339	-$32	Completed
RCI-5	Improved Appliance and Equipment Efficiency Standards	0.0	1.0	5.4	-$336	-$62	Completed
RCI-6	Building Energy Codes	0.6	4.4	28.7	-$490	-$17	Completed
RCI-7	"Beyond Code" Building Design Incentives and Targets, Incorporating Local Building Materials and Advanced Construction	0.5	2.9	20.4	-$293	-$14	Completed
RCI-8	Education (Consumer, Primary/Secondary, Post-Secondary/ Specialist, College and University Programs)	*Not quantified*					Completed
RCI-9	Green Power Purchasing (required for state facilities) and Bulk Purchasing Programs for Energy Efficiency or Other Equipment	0.0	0.4	2.5	-$9	-$4	Pending

	Mitigation Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2007–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Status of Option
		2010	2020	Total 2007-2020			
RCI-10	Distributed Renewable and Clean Fossil Fuel Power Generation	1.1	3.9	29.4	$28	$1	Pending
RCI-11	Residential, Commercial, and Industrial Energy and Emissions Technical Assistance and Recommended Measure Implementation	0.7	2.8	20.4	-$662	-$32	Completed
	SECTOR TOTAL AFTER ADJUSTING FOR OVERLAPS with RCI-1 Alternative Case 1: Mid-Range EE Investment	5.1	31.3	209.2	-$4,208	-$20	
	SECTOR TOTAL AFTER ADJUSTING FOR OVERLAPS with RCI-1 Alternative Case 2: High-Range EE Investment	5.5	35.0	232.0	-$4,736	-$20	
	REDUCTIONS FROM RECENT ACTIONS						
RCI-1	Demand Side Management Programs for the Residential, Commercial and Industrial Sectors	1.7	4.6	38.7			
RCI-2	Expand Energy Efficiency Funds	0.2	0.4	3.7			
RCI-6	Building Energy Codes	0.0	0.0	0.0			
RCI-9	Green Power Purchasing (required for state facilities) and Bulk Purchasing Programs for Energy Efficiency or Other Equipment	0.0	0.0	0.3			
	SECTOR TOTAL PLUS RECENT ACTIONS with RCI-1 Alternative Case 1: Mid-Range EE Investment	7.0	36.4	251.6			
	SECTOR TOTAL PLUS RECENT ACTIONS with RCI-1 Alternative Case 2: High-Range EE Investment	7.4	40.1	274.4			

Table 4.
Energy Supply Technical Work Group
Summary List of Mitigation Options

	Mitigation Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2007–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Status of Option
		2010	2020	Total 2007-2020			
ES-1	Renewable Energy Incentives	0.0	0.0	0.2	$3	$13.2	Pending
ES-2	Environmental Portfolio Standard	5.7	37.7	244.6	-$3,081	-$12.6	Pending
ES-3	Removing Barriers to CHP and Clean DG	0.4	1.6	11.6	$66	$5.7	Completed
ES-4	CO_2 Tax and/or Cap-and-Trade	Under preparation					
ES-5	Legislative Changes to Address Environmental & Other Factors	Under preparation					
ES-6	Incentives for Advanced Coal	0.0	8.3	66.7	$2,135	$32.0	Pending
ES-7	Public Benefit Charge	0.7	4.5	28.4	-$685	-$24.1	Pending
ES-8	Waste to Energy	0.00	0.01	0.08	-$4	-$49.9	Pending
ES-9	Incentives for CHP and Clean DG	Combined with ES-3					Completed
ES-10	NC Greenpower Renewable Resources Program	0.0	0.0	0.2	$1	$7.9	Pending
	SECTOR TOTAL AFTER ADJUSTING FOR OVERLAPS (combined with RCI)	6.4	53.3	335.13	TBD	TBD	
	REDUCTIONS FROM RECENT ACTIONS (table to be added below)	TBD	TBD	TBD	TBD	TBD	
	SECTOR TOTAL PLUS RECENT ACTIONS	TBD	TBD	TBD	TBD	TBD	

Table 5.
Transportation and Land Use Technical Work Group
Summary List of Mitigation Options

	Mitigation Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2008–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Status of Option
		2012	2020	Total 2008-2020			
TLU-1a	Land Development Planning	2.6	8.0	50.3	*Expected net savings*		Pending
TLU-1b	Multi-modal Transportation & Promotion	2.8	3.0	31.3	*Expected net savings*		Pending
TLU-3a	Feebates to raise revenue	Included in 1b			*Expected net savings*		Pending
TLU-3a	Feebates to change fleet mix	0	< 0.5	2.0	TBD	TBD	Pending
TLU-4	Truck-stop Electrification	Included in TLU-8			TBD	TBD	Pending
TLU-5	Tailpipe GHG Standards	0	8.09	40.5	TBD	-$100	Pending
TLU-6	Biofuels Bundle	1.14	3.25	20.8	TBD	TBD	Pending
TLU-7	Procure Efficient Fleets	Included in TLU-6					Pending
TLU-8	Anti-idling	0.1	0.2	1.9	TBD	-$22	Pending
TLU-9	Diesel Retrofits	TBD	TBD	TBD	TBD	TBD	Pending
TLU-10a	Fuel tax (50 cents/gallon)	6.4	13.9	95.2	*Expected net savings*		Pending
TLU-10b	Fuel tax (10 cents/gallon)	1.3	2.8	19.0	*Expected net savings*		Pending
TLU-11	Pay As You Drive Insurance	2.3	5.3	35.8	*Expected net savings*		Pending
TLU-12	Incentives for Advanced Tech Vehicles	NA	NA	NA	TBD	TBD	Pending

	Mitigation Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2008–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Status of Option
		2012	2020	Total 2008-2020			
TLU-13	Buses – Clean Fuels	Included in TLU-6					Pending
	SECTOR TOTAL AFTER ADJUSTING FOR OVERLAPS	15.4	42.84	277.8	TBD	TBD	
	REDUCTIONS FROM RECENT POLICY ACTIONS	TBD	TBD	TBD	TBD	TBD	
	SECTOR TOTAL PLUS RECENT POLICY ACTIONS	TBD	TBD	TBD	TBD	TBD	

Table 6.
Agriculture, Forestry, and Waste Management Technical Work Group
Summary List of Mitigation Options

	Mitigation Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2007–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Status of Option
		2010	2020	Total 2007-2020			
AFW-1	Manure Digesters & Energy Utilization	0.2	0.9	6.3	$387	$67	Pending
AFW-2	Biodiesel Production (incentives for feedstocks and production plants)	0.2	0.8	5.1	$286	$56	Pending
AFW-3	Soil Carbon Management (including organic farming incentives)	0.4	0.4	4.9	$-26	$-5	Pending
AFW-4	Preserve Agricultural Land	0.2	0.3	2.6	$294	$114	Pending
AFW-5	Agricultural Biomass Feedstocks for Electricity or Steam Production	0.003	0.01	0.1	0	$0	Pending
AFW-6	Policies to Promote Ethanol Production	0.9	6.9	38	$200	$5	Pending
AFW-7	Forest Protection – Reduced Clearing and Conversion to Nonforest Cover	1.7	4.3	31	TBD	$2	Pending
AFW-8	Afforestation and/or Restoration of Nonforested Lands	0.2	2.4	15	$18	$3	Pending
AFW-9&10	Expanded Use of Forest Biomass and Better Forest Management	1.4	3.6	37	TBD	$11	Pending
AFW-11	Landfill Methane and Biogas Energy Programs	0.2	1.9	13	TBD	TBD	Pending
AFW-12	Increased Recycling Infrastructure and Collection	0.2	0.5	4.1	$4	$1	Pending
AFW-13	Urban Forestry Measures	TBD	TBD	TBD	TBD	TBD	Pending
	SECTOR TOTAL AFTER ADJUSTING FOR OVERLAPS	5.72	21.89	156.86	TBD	TBD	
	REDUCTIONS FROM RECENT ACTIONS (table to be added below)	TBD	TBD	TBD	TBD	TBD	

	Mitigation Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2007–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Status of Option
		2010	2020	Total 2007-2020			
	SECTOR TOTAL PLUS RECENT ACTIONS	TBD	TBD	TBD	TBD	TBD	

Table 7.

Cross Cutting Issues Technical Work Group

Summary List of Mitigation Options

	Mitigation Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2007–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Status of Option
		2010	2020	Total 2007-2020			
CC-1	GHG Inventories and Forecasts	*Not Quantified*					Completed
CC-2	GHG Reporting	*Not Quantified*					Completed
CC-3	GHG Registry	*Not Quantified*					Completed
CC-4	Public Education and Outreach	*Not Quantified*					Completed
CC-5	Adaptation	*Not Quantified*					Completed
CC-6	Options for Goals or Targets (for CAPAG in support of LCGCC)	*Not Quantified*					Completed

Dr. Erickson

Protecting our coastal economy

asbpa

and ecology for 80 years

Beach Replenishment and the Impact of Global Warming and Sea Level Rise

There is widespread agreement among scientists that global warming is causing a rise of sea level due primarily to the melting of continental ice packs (or glaciers). While the mechanisms behind global warming are complex and multifaceted, the root cause is often correlated to greenhouse gases that essentially allow the sun's radiation to penetrate the Earth's atmosphere but trap this same radiation near the Earth's surface. The emissions of greenhouse gases such as carbon dioxide from human activities including industrial processes, fossil fuel combustion, and changes in land use have exacerbated this "greenhouse effect." [1]

Global temperatures and sea levels have fluctuated often in historic and pre-historic times, which makes human-related contributions to global warming difficult to quantify. The National Research Council examined surface temperature records for the Earth over the last 2,000 years and concluded, *"Greenhouse gases are accumulating in Earth's atmosphere as a result of human activities, causing surface air temperatures and subsurface ocean temperatures to rise. Temperatures are, in fact, rising. The changes observed over the last several decades are likely mostly due to human activities, but we cannot rule out that a significant part of these changes is also a reflection of natural variability. Human-induced warming and associated sea-level rises are expected to continue through the 21st century."*[2] In a more recent report requested by Congress, the NRC concluded that *"warming in the last few decades of the 20th century was unprecedented over the last thousand years."* [3] However, it also concluded that data was insufficient to draw conclusions that extended to a time period before 1600.

Although there are differences of opinion among scientists regarding the predicted short-term rate of sea-level rise expected for this century, the likely range of sea level increase[4] lies between 0.7 ft and 2.3 ft, with a plausible average of about 1.5 ft. This is about twice the rate of increase during the 20th Century. Predictions regarding future sea-level rise should be placed in the context that: (1) the scientific community has only presented a range of scenarios and has not agreed on specific numbers, and (2) relative sea levels will certainly rise (or even fall) at different rates in different areas depending on other factors not related to glacial melt and global warming. The potential for flooding of America's ocean and estuarine coasts is increasing due to both the impacts of sea-level rise and increased storms. With more than 50 percent of all Americans already living within a coastal county, these developments portend adverse impacts to human health and safety, the environment, and the infrastructure supporting significant portions of America's economy.

Founded in 1926, the American Beach Preservation Association (ASBPA) is dedicated to preserving, protecting and enhancing the beaches, shores and other coastal resources of America. For ocean shorelines, the ASBPA adopts an all-inclusive approach by seeking to employ a suite of tools to protect shorelines from rising seas and other forces. This toolbox may include shoreline armoring, retreat, sand bypassing and beach replenishment using sand obtained from offshore or

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[1] For a concise explanation of these dynamics, see "Planning for Sea Level Rise: U.S. Army Corps of Engineers Policy;" Kevin Knuuti; Conference Proceedings of "Solutions to Coastal Disasters '02;" American Society of Civil Engineers.

[2] "Climate Change Science: An Analysis of Some Key Elements;" The National Academies Press; 2001

[3] "Surface Temperature Reconstructions for the Last 2,000 Years;" The National Academies Press; 2006; emphasis added

[4] This represents the span of mid-range scenarios published in 2001 by the Intergovernmental Panel on Climate Change (IPCC).See http://www.ipcc.ch. The "high range" scenario is about 3 ft.

other remote locations. For moderately eroding shorelines, the ASBPA and scores of local communities across America have found beach replenishment – the placement of sand onto the beach from a source outside the eroding area – to be an appropriate solution. However, if sea level indeed rises by up to 2.3 feet within the next hundred years, some have questioned whether beach replenishment will continue to be an economic and environmentally wise choice to protect infrastructure, economies, and recreation opportunities along America's coasts.

ASBPA believes that in many areas, replenishment (also referred to as beach nourishment) is the most cost effective and environmentally acceptable approach to providing a buffer against the sea. Every replenishment project is designed to include a significant amount of sacrificial sand. This sacrificial sand is replaced at intervals of time as beaches are "re-nourished". The replenishment interval can be 5, 7, or in some cases 10 years or more depending upon the dynamics of a particular beach. Using the predicted annual rate of sea-level rise for the next 90 years is less than 0.03 foot per year[5], it is clear that sea-level rise will not overwhelm any particular replenishment project before its next scheduled infusion of sand. Even if the rate of sea-level rise is significantly higher than predicted, it is federal policy to design a beach replenishment project (e.g. the height, width, and length of beach) to account for the change in water elevation[6]. This may affect the volume of sand needed and the cost to place that sand on the beach. However, in most cases, the increase in cost to account for sea-level rise during the life of a beach project[7] will be insignificant in relation to the overall benefits provided by the beach.

Also, beaches respond to sea-level rise without our help because the elevation of the beach that lies above the high water mark (called the "berm") is developed by tides and waves. There is a reservoir of sand at the back of the beach to make up for any beach consumed by the rising ocean. Therefore, if the sea level rises, so will the beach berm by the same amount. The position of the shoreline, however, will move landward unless it is replenished with additional sand.

The alternatives to replenishment in response to this gradual rise in sea level are shoreline armoring or retreat. Shoreline armoring usually decreases aesthetics and does not preserve the sandy beach. Rather, the intersection between land and sea becomes one of steel or concrete rather than sand. Along developed coasts, the cost of retreat – that is, the abandonment of investments in coastal structures, businesses, housing, infrastructure, environmental resources, and recreational amenities – is almost unthinkable compared to the relatively low cost of maintaining a sandy beach. While either of these two alternatives may be the appropriate solution in certain circumstances, beach replenishment will remain the most physically effective, economically viable, environmentally sound method of storm protection for decades to come regardless of sea-level rise.

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[5] 2.3 feet divided by 90 years.

[6] See Knuutti; *op cit.* for a discussion of Army Corps of Engineers policy for estimating and accounting for seal level rise in the planning of beach replenishment projects.

[7] "Life" as used here refers to the statutory maximum of 50 years for the period of federal fiscal participation in a beach replenishment project.

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spotlight

No. 309 – February 20, 2007

It's Not Just a Good Idea, It's the Law

Climate Commission Ignores Legislative Mandates

SUMMARY: Any recommendations made by North Carolina's Global Climate Commission this spring will lack much of the underlying analysis required by the Commission's enabling legislation. Senate Bill 1134, which established the Commission in 2005, was explicit. It stated that the Commission "shall conduct an in depth examination" of a list of important scientific and economic issues. After over a year of meetings the Commission has ignored what any reasonable observer would conclude are the most important questions.

Any recommendations that are made by North Carolina's Global Climate Commission this spring will be premature and will lack almost all of the underlying analysis required by the Commission's enabling legislation. In 2005 when the North Carolina General Assembly enacted Senate Bill 1134 (SL 2005-242), which established the Legislative Commission on Global Climate Change (LCGCC), they were quite explicit in their directions to the Commission. In particular, they stated unequivocally that the Commission "*shall conduct an in depth examination*" of a list of important issues (see "a - g" in the accompanying excerpt from the bill). Whether through negligence or willful omission, after a year of meetings, the climate Commission has made no significant attempt to pursue their mandated mission. In fact, they have completely ignored what any reasonable observer would have to conclude are the most important questions.

Science, Economics, and the Law

Except for letter "b" the tasks assigned to the commission by the legislature fall under one of two categories of analysis: scientific and economic. Letters "a" and "c" mandate that the commission examine possible alternative explanations of global warming and the impact on the climate of proposed policies respectively. Letters "d" through "g" focus on issues related to both the costs and benefits associated with possible future climate change and policies proposals meant to mitigate this change. All of these requirements are quite sensible and they show a clear understanding on the part of the legislature of the full body of questions that need to be answered before the state should proceed with

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public policies in this area. If the commission followed its mandate and in fact pursued an "in-depth" examination of these issues it would be providing a body of resources and analysis that would be indispensable to intelligent law making.

Unfortunately both the General Assembly and the citizens of North Carolina are being shortchanged. The Commission is ignoring its legislative mandate and is not pursing analysis of any issues that are likely to undermine what appears to be a predetermined position on the part of a majority of Commission members and its co-chairs, Representative Joe Hackney (D-Chapel Hill) and Attorney John Garrou from Winston Salem. That position is to forge ahead with policies meant to restrict emissions of carbon dioxide (CO_2). This is the greenhouse gas thought by many scientists to be at least a partial cause of the global warming that has occurred over the last 100 years and much greater warming that some of these same people believe is about to come in the next 100 years. As a reminder, this is also the gas that is exhaled by human beings and is the ultimately responsible for all plant life and therefore all life on earth. This is hardly a pollutant in the traditional sense.

Missing Science: possible causes of warming

Letter "a" calls for the commission to conduct a review of the scientific literature regarding the "possible natural and anthropogenic causes of global climate change." The term anthropogenic refers to climate change induced by human activity while natural refers to climate change that one might expect to see in the absence of human activity and that has occurred throughout the history of the planet. This would include the intensity and activity of the sun and other naturally occurring variations in climate.

After a year of meetings the commission has not heard any testimony on possible natural causes of climate change and with respect to anthropogenic, i.e. human, causes, testimony has focused strictly on man made greenhouse gasses such as carbon dioxide. This is in spite of the fact that there are other possible human induced causes of rising temperatures as recorded by ground level thermometers. For example, it is well known that economic development activity around official thermometer locations, for example new buildings and roads, tends to increase local temperatures over time. This is what has come to be called the "heat island effect." In other words, to some extent what is being observed as global warming could be the collective results of local warming from communities where thermometers are located around the globe. In a recent story from the *Triangle Business Journal* Ryan Boyles, the North Carolina State Climatologist, is cited as claiming that studies from his office show that climate change in North Carolina is more closely related to this local effect. He state that "local climate change patterns are more closely linked with development-land use, the way we urbanize..."[1] Yet climate data from North Carolina, and other areas around the world that are influenced by the heat island effect, is going into the averages of global temperatures. To date there has been no discussion or testimony regarding the extent to which the heat island effect is the cause of changes in global temperatures.[2] To the extent that it is, policies that are focused strictly on reducing CO_2 will be irrelevant.

As noted there have been no hearings on the extent to which global warming may be due to natural causes, such as increased sun intensity or natural climate cycles. For example, a 2006 study published in the *Geophiscal Research Letter* suggests that half of the warming in the last century was caused by increased sun intensity.[3] There are also climate scientists who argue that part of the recent warming may be due to natural cycles. The point is that none of this science has been vetted as is required by law.

Will the Policy Make a Difference? More missing science

From a public policy perspective the most important requirement of the legislation is put forth in letter "c." It requires the commission to conduct an in depth examination of "the extent to which reductions in the emissions of [greenhouse] gases in the State, region, and worldwide could be expected to affect global climate change." The answer to this question should be the basis of all the work that is being conducted by the Commission.

The proclaimed purpose of any policy meant to force or induce people to cut back on greenhouse gas emissions is to reduce global temperatures in the future. If the proposals being made will not in any way accomplish this purpose they should be discarded out of hand.The fact is, the commission has made no effort to comply with the requirements of

the law in this regard. It has heard no testimony from qualified climate scientists, or anyone else, regarding this issue. In a recent letter to the Commission Chair's two of the Commission members noted this omission in the proceedings and suggested that "the Commission attach a qualified assessment of the climate impact over whatever timeframe is deemed relevant, to each policy recommendation that is made. This would insure that we are complying with both the letter and the spirit of the legislation."[4] This proposal not only makes sense in terms of the ultimate goals of the Commission but also is an implicit requirement of the law.

Text from S.L. 2005-242 §5(1)(a-g)

This examination shall include all of the following:

a. A review of current scientific literature on the possible natural and anthropogenic causes of global climate change.

b. A review of actions taken by the federal government and by other states to address global warming.

c. An examination of the emissions of greenhouse gases from within the State and the extent to which reductions in the emissions of these gases in the State, region, nation, and worldwide could be expected to affect global climate change.

d. An evaluation of the economic opportunities for the State that may result from international, national, and State action to address global climate change and the emerging carbon market.

e. The potential impacts of global climate change on the citizens, natural resources, and economy of the State, including agriculture, travel and tourism, recreation, coastal real estate, insurance, and other economic sectors.

f. The costs of any action taken by the State to address global climate change on individuals, individual households, local governments, businesses, educational institutions, agricultural operations, the State government, and other institutions and economic sectors.

g. The benefits of any action taken by or within the State or other states and at the national or international levels to address global climate change on individuals, individual households, local governments, businesses, educational institutions, agricultural operations, the State government, and other institutions and economic sectors.

Economics: the other missing shoe

> In almost every case, we have received an economic analysis, and a number of the proposals we are looking at have a net economic benefit to the state.
> — *John Garrou, Commission Co-Chair*[5]

This was the response by Mr. John Garrou, Commission Co-Chair when asked on a recent radio program if the climate commission was pursuing economic benefit-cost analysis of alternative policies it is examining. But Mr. Garrou was mistaken. Not only has the Commission not been presented with benefit/cost analysis showing "a number of policies" that have a "net economic benefit to the state," there has been no benefit/cost analysis of any policies being considered by the Commission. In fact, there is no evidence that any real benefit/cost analysis has been done or is even in the process of being done.

It should be noted that The Climate Action Plan Advisory Group (CAPAG), a study group established by the North Carolina Department of Environment and Natural Resources (NC DENR), has hired a consulting firm to perform what might be called cost effectiveness analysis. This analysis looks at what are the most cost effective ways to reduce CO_2 emissions in the state. The Climate Commission is planning to consult the CAPAG analysis when making recommendations. This is not economic benefit/cost analysis and does not answer the questions posed by the legislation.[6] While this analysis might show policy makers what the least expensive ways to reduce CO_2 are, it does not analyze the climate change benefits that the CO_2 reductions are supposed to bring about. It also does not take into account any benefits to the state's agriculture industry of a CO_2 enriched atmosphere. A 1995 article in the journal *Science* notes, "[I]n the agricultural realm, experimental evidence suggests that higher CO_2 concentrations may be a boon, helping many crops grow faster and yield more."[7] This implies that increases in atmospheric CO_2 will have benefits that any meaningful benefit/cost analysis would have to include when discussing the costs and benefits of CO_2 reduction policies. It should be noted that some of the best economic analysis done in this regard, by Robert Mendelsohn and James Neumann, has argued that the benefits to the U.S. economy from increased atmospheric CO_2 will completely offset the damage costs of future global warming.[8]

The consulting firm, The Center for Climate Strategies, comes into the process with a set of predetermined conclusions that may prevent its analysts from being objectective in their assessments. On its web site the Center claims that "Climate actions by states can significantly reduce the growing burden of climate change risk that we face."[9] But they provide no scientific bases for this claim. As noted above this is not a conclusion that the Climate Commission has the luxury of taking for granted. In fact the Center is assuming away the most fundamental problem that the Commission is charged with addressing. What the Center for Climate Strategies is assuming is in fact the answer to

an open question that the Commission is mandated by law to investigate. Therefore, it is improper for the Commission to be relying upon analysis of a consulting firm for whom the only relevant question is how should CO_2 reduction policy be carried out and not whether or not such policies make sense in the first place.

What seems inexplicable is that DENR would not take advantage the vast array of very qualified Ph.D. economists in the UNC system to pursue its economic analysis. Instead it has hired an outside consulting firm that is biased in its presuppositions and whose income depends on state governments pursing global warming initiatives. It appears that DENR hired a firm that would give it the results it wanted. Consequently the Climate Commission should conduct its own benefit/cost analysis making sure that the analysts that are employed are qualified economists who above reproach in terms both financial self interests and ideological or advocacy biases.

Conclusion

It is clear that the North Carolina's Global Climate Commission is not ready to make even interim policy recommendations to the General Assembly. In its proceedings thus far it has ignored most of the of analysis that its legislative mandate requires it to pursue. With over a year left before a final report is due, the Commission still has time to compile the information and analysis that the laws requires. But the analysis that remains to be done is extensive and the work can only be accomplished if the Commission takes its mandate seriously, without predetermined conclusions guiding the process. At the present time this result seems unlikely. To date the apparent purpose of the Commission has been to build a case for CO_2 reduction policies and only to follow its legislative mandate where the requirements of the law overlap with this goal. In other words, it appears that the Commission sees itself primarily in an advocacy rather than an investigative role. With potentially very costly policies in the balance, the citizens of North Carolina deserve a fair and unbiased Commission that is willing to critically all of the evidence.

Roy Cordato is Vice President of Research and Resident Scholar at the John Locke Foundation.

NOTES

1 Leo John, "State seeking to identify its role in global warming fight," *Triangle Business Journal*" 9/25/2006.

2 While there has been adjustments made to some of the climate data to try to account for the heat island effect, recent research suggests that these adjustments still understate the problem. See Ian G. McKendry, "Applied Climatology," *Progress in Physical Geography*, Vol. 27, No. 4, 2003, pp. 597-606.

3 N. Scarfetta and B.J. West "Estimated solar contribution to the global surface warming using the ACRIM TSI satellite composite" *The Geophysical Research Letter,* Vol. 32, 2005.

4 Letter written and made available to the author by Commisioners Sen. Robert Pittenger and Dr. Ed Erickson of North Carolina State University. Addressed to Commission Co-Chairs Rep. Joe Hackney and John Garrou, January 31, 2007.

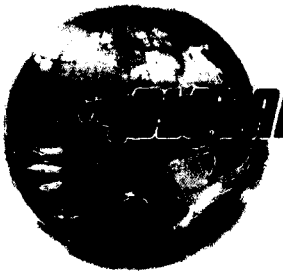
5 Statement made on "Capital Close-Up," State Government Radio, January 15, 2007.

6 It should be pointed out that of the18 analysts listed on The Center for Climate Strategies web site none have an advanced degree in economics and only one person lists even a bachelors degree in economics as a credential. See http://www.climatestrategies.us/team.cfm.

7 Elizabeth Cullota, "Will Plants Profit From CO_2?", *Science*, Vol. 268, May 1995, p. 654.

8 Mendelsohn and Neumann, ed., *Global Warming and the U.S. Economy,* (North Hampton, MA: Edward Elgar) 2001.

9 The Center for Climate Strategies http://www.climatestrategies.us/Why_Elected_Officials.cfm. It should be noted that this is a false and scientifically unsupportable claim. It is now widely acknowledged that even the United Nations Kyoto Protocol would have an unmeasurable impact on the climate. (See Thomas Wigley, "The Kyoto Protocol: CO_2, CH_4 and Climate Implications," *Geophysical Research Letters,* July 1, 1998.) In fact climate scientist and well known global warming alarmist Dr. Jerry Mahlman claims that it would take CO_2 reductions that are the equivalent of 30 Kyoto Protocols significantly to impact the climate. (See David Malakoff "Climate Change: 30 Kyotos needed to control warming" *Science*, December 19, 1997 found at http://www.sciencemag.org/cgi/content/full/278/5346/2048.)



L WARMING INITIATIVES, INC

Turning Energy Efficiency and Environmental Performance into a Corporate Asset.

Coming Soon

As soon as 2009, the United States government will pass legislation to cap emissions from all sources that emit over 10,000 metric tons of carbon dioxide per year. The emissions allowed under the new cap are then divided up into individual permits that represent the right to emit that amount. Companies that emit under their allocated amount can trade their excess permits to companies that emit over their cap. This is known as the cap and trade system. G.W.I. will aggregate emissions credits from small to medium sized entities into economically viable bundles for trade.

Our Mission

Our goal is to prepare companies for federally mandated greenhouse gas legislation. We accomplish this goal through a series of steps. First, we collect all pertinent data from our clients. Next, we perform an energy survey. The energy survey is designed to calculate and track both emissions and energy use. After reviewing our findings with our clients, we then report non-confidential emissions to the U.S. Department of Energy. The next step is to help our clients develop an action plan that will enable them to achieve greater efficiency. The final step is for companies to increase their assets and sustainability.

G.W.I. Energy Survey

The energy survey provided by Global Warming Initiatives is the most comprehensive energy survey available in accordance with the technical guidelines specified by the DOE Voluntary Reporting of Greenhouse Gases [1605(b)] (VRGG) Program, EPA Climate Leaders, and the WRI Greenhouse Gas Protocol. The G.W.I. energy survey employs the following tools of analysis:

- Intensity Reduction Analysis – In Both MMBTU's and MT CO_{2e}
- Absolute Reduction Analysis
- Monthly Emission Analysis
- Monthly MMBTU Analysis
- Emissions/Energy Intensity Analysis
- Yearly Emission Analysis
- Yearly MMBTU Analysis
- Energy Consumption Analysis
- Energy Usage/Cost Comparison Analysis
- Long Range Energy Consumption Forecast
- Long Range Energy Cost Forecast
- Long Range Emission Forecast
- Carbon Tax Scenarios
- Cap and Trade Scenarios
- Water Usage Analysis/Forecast

James Haven, Chief Executive Officer, (919) 515-0700, jhaven@gwi-nc.org
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**Please visit our website at www.gwi-nc.org
A Non-Profit 501(c)3 Public Benefit Corporation

Why Use G.W.I.?

Reduce Energy Use and Save Money ... In 2005, our clients reported emitting a total of 462,118 metric tons of carbon dioxide (MTCO2e). They also reduced their emissions a total of 44,029 MTCO2e and saved a total of $4,992,514. This translates to average reductions of 1967 MTCO2 and savings of $416,042. This instant savings is a result of the knowledge you gain from G.W.I.'s energy survey and it goes right to your bottom line.

Turn Energy Efficiency into a Corporate Asset ... In practice, cap-and-trade systems create a financial incentive for emission reductions by assigning them a cost. Those that are able to reduce emissions at a low cost can sell their extra permits to companies facing high costs. When a federal cap and trade system becomes mandatory, those who have their emissions records will gain the most.

To Be Good Stewards ... Human activity has been increasing the concentration of greenhouse gases in the atmosphere. Pre-industrial levels of carbon dioxide were about 280 ppmv and current levels are about 370 ppmv. The concentration of CO2 in our atmosphere today has not been exceeded in the last 420,000 years.

Our Credentials

Phase 1 -- The pilot program started with a single manufacturing firm signing the DOE/EPA Partnership Agreement on September 1, 1996. The agreement was to identify and implement cost-effective energy efficiency, pollution prevention measures, and to calculate MT CO_{2e} emissions. The agreement also stipulated that emissions were to be reported annually to the EPA and DOE through the Voluntary Reporting of Greenhouse Gases Program. This phase was completed in good standing on June 30, 2002.

Phase 2 -- Phase 2 continued with the efforts of Phase 1, only now the funding for reporting and emissions calculations came directly from our clients. Each of our clients provided year end data and continued in their efforts to reduce energy consumption and emissions. Phase 2 concluded with the 2005 year end reports.

Phase 3 -- Phase 3 began June 1st, 2006 with the enhanced version of the D.O.E.'s Voluntary Reporting of Greenhouse Gas Emissions [1605(b)] Program. This phase includes both registration and reporting of greenhouse gas emissions to the D.O.E. This phase also includes a GWI Energy Survey as well as environmental consulting services. GWI also establishes and tracks an action plan to guide efficiencies.

Phase 4 -- Phase 4 will include the reporting and registering as outlined by Phase 3, a GWI Energy Survey, and environmental consulting services tailored to the new registry scheme. Phase 4 will also comprise of the trading and brokering of greenhouse gas emissions credits, which could be sold as MT CO_{2e}. These credits will be either stored in our "virtual silo" for your company's later use, or sold on a private or public market. GWI is also tracking the carbon tax scheme. GWI is already performing all services associated with Phase 4 and beginning with the 2006 Year-End data. GWI expects a nationwide cap and trade system to begin within the next two years. GWI clients already reporting their emissions will possibly get early action credits if approved by Congress.

"In the U.S., it is no longer a matter of if, but when and how a cap and trade system will become mandatory. Understanding the opportunities and the pitfalls could be the difference in grabbing this financially beneficial and socially conscious brass ring or missing the boat."

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Global Climate Change Commission Meeting
Tuesday, October 23, 2007
10:00 a.m.
Room 643 LOB

The Legislative Commission on Global Climate Change met on Tuesday 23rd October in Room 643 of the Legislative Office Building with Representative Pricey Harrison, Co-Chair, presiding until Mr. Garrou arrives. Other members present were: Sen. Albertson, Sen. Cowell, Sen. Pittenger, Rep. Thomas, Rep. Underhill, Rep. Wilkins, Dr. Eggers, Mr. Tim Toben, Mr. Urlaub, Ms. Choi, Mr. Everett, Mr. Howard, Mr. Peele, Dr. Phaneuf, Mr. Profeta, Dr. Riggs, Ms. Prayer, Mr. Slocum, Dr. Smith, and Dr. Uzochukwu. The visitor registration is Exhibit A.

Representative Harrison called the meeting to order and indicated that Co-Chair, Mr. Garrou is on his way to the meeting having traffic problems on I-40 and gave the floor to Mr. Givens for introductory remarks.

Mr. Givens welcomed everyone and gave a few introductory remarks. Chairman Garrou is in route and expected to be here in another thirty minutes or so. A tractor trailer overturned that blocked all of the lanes on I-40 and that is probably what has some of the other members as well. With regard to changes in membership, I will recognize each new member and indicate if you wish to say anything. We have a continuing member who has been appointed by the Speaker to replace himself as the House Co-Chair, Rep. Pricey Harrison. We welcome you as Chair. Rep. Harrison states she is looking forward to work with everyone. Rep. Lucy Allen could not be with us today, she has been appointed to replace Rep. Harrison as a member. Rep. Charles Thomas has been appointed to replace Rep. Wilma Sherrill. Rep. Thomas said thanks and he's just glad to be here from Bumcombe Co. Jane Preyer is the Executive Director of the Environmental Defense and has appointed herself to replace Michael Shore who previously represented Environmental Defense and has moved on to other employment. Other than Rep. Allen the only other member that I know has contacted me about scheduling conflict and not being able to attend is Susan Thompson. Ms. Utley has not been contacted by anyone. Mr. Givens told the members that it is always helpful when we know when you are in route or may have some difficulty in getting here and being late versus whether you can't make the meeting.

You have been given a revised membership list (Exhibit B), please look and make sure that your information is correct. If it is not correct, talk to Ms. Utley and we will correct it for you. There may be another change or two in membership caused by people resigning their academic appointment. With regards to the agenda this morning(Exhibit C), a lunch break was not scheduled hopefully we can finish before lunch. Adjournment is expected sometime between 1 and 2. The agenda is straightforward. Our first presenter is from the

PEW Center with an update on what is happening around the nation on climate change since we last had an update about a year ago, Pat Hogan will be presenting that. Agenda Item #5 - Mr. Givens will be talking about Senate Bill 3. The most important item is Item #6 – the Climate Action Plan Advisory Group met a week ago today and made its recommendations for consideration. There are 50 some of those, they will be presented by Mr. Tom Peterson.

Last you will hear from the folks at Appalachian State on what they characterize as draft preliminary results of a macroeconomic analysis. We wanted you to hear where that stands and perhaps give some guidance to that work which will be presented by David Ponder, Graduate Research Assistant.

The co-chairs have settled on some tentative meeting dates and they are on the back of your agenda. The next meeting is scheduled for the 4th of December. We can make adjustments if we find that a lot of members cannot have conflicts on a particular date.

Your attention is called particularly to the February meeting because I want you to be aware of the plans for that. The Emerging Issues Forum will be focused on energy this year. That forum will be held on Monday and Tuesday, the 11th and 12th of February. One of the speakers they expect to have is the chair of International Panel on Climate Change, the IPCC. They've just issued a new report and a recent co-recipient of the Nobel Prize. It may be that we will schedule our meeting at the McKimmon Center on Monday or Tuesday in connection with the Emerging Issues Forum. I ask you to hold those dates on your calendar and we will keep you posted and free up the dates we don't intend to use as soon as possible. I think the topic will be of great relevance to this Commission and I think it may be possible that we can work out some coordinated attendance perhaps this Commission would even be in position to pay these registration fees. I will have to investigate that.

On the matter of the Interim Report – we last met in February and we spent a good deal of time going over various recommendations and taking votes and then the staff was instructed to prepare an interim report. Chairman Hackney and Chairman Garrou felt that there need to be some further mechanism whereby you saw it one more time before the report was made. The report was placed in my box of items to be reviewed and promptly covered up by bill drafts. There is a draft interim report, it has no official standing. We are discussing what if anything to do about it, the practical accomplishment of this process is the enactment of the energy bill Senate Bill 3. Once we get in session, we have to suspend work on interim activities and we just simply don't have time.

At this time I would like to introduce to you Terry Nordon who is the vice counsel for Science and Innovation with the British Consulate General's Office in Atlanta. He is visiting us today, as you know, we've had an ongoing discussions with the British Government and particularly the Atlanta Consulate General. They were

the sponsors of the best reception that I attended during the 07 Session. Ms. Nordon.

Ms. Nordon: Good morning. Thanks for having me here.

Mr. Givens: We have a Commission website where we try to post documents relative to this Commission. Ms. Mundt informs me that we will promptly post all documents that are associated with this meeting. I encourage all visitors in the audience to sign the visitor registration. Members please get in your reimbursement forms, the quicker we get them from you the quicker you can get paid.

Chairman Harrison: At this point I would like to recognize Patrick Hogan from the PEW Center on Global Climate Change and thanks for making the trip down here.

Mr. Hogan: Thank you very much for bringing me down here today and giving me the opportunity to speak to you all. Many of you heard from my colleague Josh Resinki about this time last year in October 2006 and I took from the agenda that I am going to be giving an update on national and state level action on climate since last October. I also am going to talk a little bit about what has been going at the international level. So just to give you an overview of where we are headed and I should preface it by saying that a lot has happened in the past year so it is an awful lot to take in and I've tried to just pull out the highlights but it may seem like a bit of an information dump at times. I'll be giving some quick highlights from the international policy landscape followed by an update on federal and congressional actions here in the states including an update on what the 2006 congressional elections mean for climate in the U.S. The current policy landscape here in the U.S. and some other major initiatives at the federal level and then I will wrap up with state and local updates and tell you some of the highlights from state action from around the country.

This is really a policy update so I haven't included anything on the science. I am happy to talk about that during the Q&A session if you have any questions. But there have been a lot of development in climate science as well in the past year. Whenever you talk about climate change and climate policy at the international level it is helpful to think about how different parties come to the negotiating table and why there are such different perspectives on what different countries should adopt as their responsibilities for addressing this problem. Hopefully, I know the numbers are a little hard to read (Exhibit D) but the sketch of side by side comparisons of cumulative emissions for each of these countries as well as total annual emissions at the moment. The US is the largest annual emitter of CO_2 from energy use followed closely by China and then the 25 year countries. Together the US, China and the EU make up well over half of all the energy related CO_2 emissions in the atmosphere. Although official data is not available yet, it looks like based on preliminary evidence and estimates that China may

have actually just surpassed the US as the top annual emitter this past year. If it wasn't last year it is going to be this year or the year after, sometimes very soon. While much of the climate policy debate especially here in the US focuses on annual emissions, what really matters from a scientific perspective is cumulative emissions. Since greenhouse gases, CO_2 especially stay in the atmosphere not just for a year but for hundreds of years. So it is really that build up of gases over time that matters. If you look at the cumulative emissions side by side of the annual emissions, the US's share is closer to 30 percent and the EU's is pretty close as well, it's around 27 percent. While China has just contributed 7 percent of cumulative emissions so everything is already up there. So this evaluation of historic responsibility that shapes the demands and viewpoints of the developing nations like China when they come to international climate negotiating tables. This just offers another cut at looking at the international emissions landscape on a per capita basis. The US is about four times the world average on a per capita basis for CO_2 emissions, China is just below. Even compared to other developed nations the US is pretty out in front on this one. We on a per capita basis emit about twice as much as the European Union or Japan.

Now just to go through some of the highlights from international theme this past year, a group of eight summits in June 2007 called for a global agreement on a post 2012 framework under the UN Framework Convention on Climate Change in 2009. Within the UN itself at the end of September, there was a high level meeting held in NY with over 150 countries in attendance, many high level delegates and the goal of the meeting was to send a strong political signal to accelerate upcoming work at a meeting which I'll talk more about in just a moment. What was really evident from this meeting, unlike in many previous forums, is that by and large all of these countries are no longer questioning the science, they've really gone under the question of what to do about this issue. I think of the 150 delegates in attendance just one was saying that the science wasn't good enough there is no need to act. Everyone from the other 149 countries was saying that we need to get the ball rolling on a new framework. Of course another major international event was the meeting held just shortly after the September meeting – this was a meeting organized by the President to bring together the 15 top emitting economies that includes both developed and developing countries. What really emerged as the issue at this meeting was the distinction between voluntary versus binding commitment and who should adopt which. President Bush's vision has remained largely unchanged during his time in office and he's calling for a long term international goal, but individual countries would not be subject to any sort of binding emissions cap or commitment. The bill would be reached purely on a voluntary basis alone. At this meeting, 14 other nations present basically said this is not good enough we need binding commitments of some sort. Even China and India are saying look binding commitment doesn't necessarily mean targets for everyone but it means that every country has some sort of policy commitment to help address this issue and they are willing to adopt some sort of policy that could help produce their energy consumption and make them more efficient.

You may have also heard another major international development very recently, former Vice-President Al Gore and the UN Intergovernmental Panel on Climate Change shared a Nobel Peace prize and I guess many of you have already seen An Inconvenient Truth. I've heard that the DVD sales are doing very well – it's been booming, but we will actually never know exactly how many copies were sold because the Supreme Court intervened to say stores have to stop counting how many people buy it. Little bit of a problem. That's a joke. The Supreme Court has done lots of stuff but not quite to that level. Looking ahead if we ask the question what's the likelihood of a new international framework coming together any time soon, it's very unlikely that real negotiations are going to happen any time before 2009. The first chance to get that process moving is this upcoming meeting in December. It's really a potential to launch a new UN process, it's the first chance for nations to come together and talk about and submit their proposals for what post 2012 framework should look like. I keep saying post 2012 because 2012 is when the Kyoto protocol commitment period expires and that is the current international framework that many nations are offered.

Just looking at some other major emitters around the world and actions that they've taken this past year – Australia has historically been pretty skeptical of taking action on climate. Of course in addition to the US they were the only other developed industrialized nation not to ratify the Kyoto protocol. However due to a number of circumstances, one of which may have been a pretty devastating drought that hit Australia this past year. They are now thinking seriously about setting a cap and trade scheme on reducing emissions through emissions trading. If that does need to go forward it will commence some time between now and 2012. New Zealand Australia's neighbor is also thinking of setting up an emissions trading scheme. European Union of course already have their scheme up and running and it is functioning pretty well. Especially considering it's a new market – the first program of its kind and it is very ambitious and it covers CO_2 emissions from over 12,000 facilities across the European economy. You can see trading volumes have been pretty high just in the first stage. The first stage which ends fairly soon, 2008, was set up as really a learning phase to help the system find its leg and get the kinks out. The Kyoto commitment period is 2008-2012 and they hope to have everything ironed out amongst the market really functioning smoothly. The EU of course has also issued some pretty aggressive statements regarding global climate as well including a 20 percent renewable portfolio standard for the EU. They are putting a lot of effort into funding carbon capture and sequestration projects and committed to reduce greenhouse gases 20 percent below the 1990 levels by 2020 and will go even further if other developed nations, mainly the US agree to similar cuts.

Leaving the rest of the world behind focusing in on what's been going on at the federal level here at home. Of course the democratic victory in the 2006 election has a lot of implications and ramifications through many policy areas but

especially climate change. I will not go through all of these names but all of the key committee leadership posts in the House and Senate have been filled by democrats who have pledged to make climate change a priority and already have in many cases. The senator from California which is kind of a poster child for state action on climate change has certainly made this a priority and really wants to get a bill through her committee. She of course replaced the former chair who declared that climate change is the greater host of all times. This change in Congress is just one reason that this has been a kind of key change amongst industry and large businesses this past year as well. Not only is this increasingly recognized in the US action on climate is no longer a question of if but really a question of when. They are also starting to embrace it – this change in attitude is due to a number of factors, the democratic congress increasing likely other legislation. Of course the states are continuing to exert a large amount of pressure with all the steps that they are taking. Other countries are calling on the US to step up and take substantial leadership on this issue. US public pressure is probably at an all time high, which corresponds to a greatly increased awareness among the US public of this issue and what it could mean. There are a number of other reasons but many are starting to see it as this is coming sometimes very soon.

One of the reason it makes climate change regulate greenhouse gas regulations or legislation fairly likely is the Supreme Court's decision from earlier this year in MA et al. vs. EPA which many of you may have heard about. Especially in this case, MA several other groups sued the federal EPA for not regulating emissions of four greenhouse gases especially CO_2 from the transportation sector, auguring that under the clean air act EPA had not only authority but a duty to regulate these air pollutants since they threaten public health and welfare. The EPA of course said the opposite, we don't have the authority to regulate these gases, it is not our responsibility. Ultimately the Supreme Court sided with the states in what is pretty landmark ruling. The court ruled that the EPA not only has the authority to regulate CO_2 and other greenhouse gases under the clean air act, but that the EPA has a duty to protect public health and welfare under the act. Essentially told them you need to go away and rethink your position and once you can come up with a really good excuse for not regulating these gases you need to do so. Essentially the EPA would have to prove that CO_2 and other greenhouse gases don't cause climate change which at this point would be pretty difficult to do. This obviously has implications for potential regulation of the vehicles and stationary sources by the EPA, and also implications for a CA proposed greenhouse gas standard for vehicles.

I had mentioned before that businesses are starting to wake up and are not only seeing climate legislation as very likely but are also looking to embrace it and thinking it could be a good thing. Probably no where has it been more evident than in the US Climate Action Partnership which you may have also heard about emerging with (inaudible) I believe. Initially this was a group of about 14 including several large major players in business and industry from every sector

of the economy. It includes major utilities, oil companies, auto manufacturers, and a host of others. The partnership started with some of these companies and a hand full of (inaudible) including the PEW Center. Since the initial inception the US cap has grown substantially – it now has 33 members total, 27 of which are as large corporations. US cap emerging goal and with what they're calling for is rapid enactment of legislation at the federal level that creates a mandatory but flexible climate program. It includes some sort of market program especially cap and trade that reduces emissions on a steadily declining float towards 2050 and promote technology research development and appointments. The important thing about the US cap target that these businesses have endorsed is that they are informed by where the sciences simply need to be based on the latest science. In order to avoid dangerous build up of greenhouse gases that can lead to really unpredictable and potentially dangerous climate change, we need to reduce emissions somewhere between 60 and 80 percent from current levels by this century. US cap targets call for a long term target in that area.

I am not going to run through everything on this slide because it is very wordy. I think it is important to look at this and think about the contrast between the current situation encountered and how things were in the 109th – it's a very different story in the 110th. There have already been less than a year in the current congress over 125 bills, amendments and resolutions related to climate including a record number of cap and trade system proposals, and this combined with a number of hearings if you compare that to action in the 109th across two years, I don't think the number came anywhere near that, so that's pretty significant. Action in the congress in the 110th is also included the formation of select committee on energy and the effects of global warming in the House. So I am not going to go into great detail on a lot of the specific bills other than to illustrate how they stack up. The one pretty significant piece of legislation that was just released last week is a new proposal from Senators Lieberman and Warner. And it is significant is not leaked because it is bipartisan in nature and has a pretty decent chance of passage and getting out of the Environment and Public Work Committee. The bill is sponsored by the two senators listed above and by several others on both sides of the isle as well and I should note that includes NC Senator Elizabeth Dole. The Lieberman-Warner bill would basically take a very strong step towards getting the US where it needs to be in terms of emissions reduction. It was set up in an economy wide cap and trade program covering transportation fuels, utilities and other large sources are also driving climate friendly technology development and innovation. The target would establish our ambitious yet certainly achievable – they get up to kind of a low end of where the science that we need to be about 65 percent below current levels by 2050.

I am not going to read the individual names here but this just shows how the six major cap and trade proposals in the Senate stack up against one another in historical emissions or business as usual emissions. So if we continue to do nothing we will end up on this sort of deep red clarifying slope that goes off into

infinity – that is what we really want to avoid. You can see that the six major proposals in the Senate basically all get us more or less where we need to be. Some of them have more or a declining slope over time, some take more of a step approach but really they all get us to where we need to be in the long term. You can also see in the graph the US cap recommended target represented by the grey band that a lot of the bills fall into. If the safety valve is hit then the Bingaman bill would look pretty different and probably would not get us the emissions reduction we need.

Now we are going to leave the Senate behind and get onto what I think is really the most exciting stuff going on around the country. The site wise this might look like it is not a matter of congressional redistricting gone terribly wrong, this is just to make a point that sometimes when I start talking about state action and climate people raise the question "Why does that matter?" and in the states are tiny, how can their emissions production make a difference? The truth is that state emissions are pretty significant – they're significant contributors to the problem and can contribute significantly to a solution. So the numbers on this map have changed a bit in that China is closer to the equivalent than all the states on this map. But the basic point is still the same and that is when you just start talking about a handful of states, four states in the west, a handful of states in the northeast, you're talking about emissions equivalent to those terms major admitting economy around the world. So working together or individually, states can make a significant dent introducing absolute emissions.

So you heard from Josh last year, I believe he talked briefly about the regional greenhouse gas initiative and I'll just give a quick update on what's happening with that. Just as a quick refresher, RGGI as it is affectionately known is the first mandatory US greenhouse gas cap and trade program, first program of its kind in the US. Its goal is to stabilize power plants CO_2 emission. The current levels between 2009 and 2015 and then reduce those emissions 10 percent below current levels by 2019. So when it first started RGGI had just seven states signed on and just within 2007 that number has gone to 10 as MA, RI, MD have all joined which means that RGGI, if you think back to the math I just showed, now that those states involved admit 10 percent of total US emissions and are equivalent to the 8th largest emitter in the world Canada. At the moment RGGI is still in the implementation stage, it is not really going to get up and running until 2009. At the moment individual states are adopting RGGI's model rule which is kind of a blue print for how RGGI is going to work and individual states have to adopt it through (inaudible) or regulation. States are also working on allowance option design. How they are going to distribute the emissions allowances under the cap and trade program. There are of course two broad categories of doing that, you can give away allowances for free based on some metric or you can auction them off and emitters have to pay for them up front. And you can auction some of your allowances, you can give some of them away for free, you can mix and match and do a bit of both. What is interesting is that many of the states are committing to or seriously considering 100 percent auction of their allowances

which is a pretty significant change from where things were about a year ago. Massachusetts actually just released its draft auction rule which was set up a 100 percent of the auctioning of allowances. RGGI is also close implementing their regional organization which will oversee and coordinate a program working on leakage issues and being able to attract imported electricity. Leakage is an issue whenever you have a group of states adopting regulations, especially in this case, rules and regulations of greenhouse gas emission as it is possible that those emissions will simply get pushed out of the capped region states may end up importing electricity produced outside of their borders that have high greenhouse gas emissions associated with its production.

Mr. Profeta: They're working on a system that will track the leakage at this point not a system that will actually have any program to control the leakage is that right?

Mr. Hogan: Exactly. So you also may recall that last year Josh talked about California's action especially the passage of 8032 A Global Warming Solutions Act of 2006 which set the first binding economy by targeting as many states and will hopefully get California to 1998 emissions level by 2020. Probably they are still thinking about how they are actually going to do this, it's great to set a target but then as you all know it's very difficult to figure out the way to meet it. One thing that is going to set with me is the release of California Market Advisory Committee report earlier this year. The committee was formed after a clash with the governor - 8032 authorizes the use of market mechanisms such as cap and trade and the committee's objective was to come up with what that system might look like and make recommendations for its design. And while it is likely that a market will be adopted in California, it is not a sure thing but either way this is a very comprehensive piece of work and it is well worth looking at. Also another major development in California just from January was the announcement of the nation's first low carbon fuel scanner in the state which aims to reduce the carbon intensity of vehicle fuel sold in California 10 percent by 2020. It's worth noting that when the state carbon intensity that means this reduction applies across the life cycle basis – so it's not just looking at tailpipe emissions, it's the wheel to wheel emissions associated with a gallon of fuel. So it takes into account emissions from transportation of fuels, from refining it and the whole production process. So it actually allows a fair amount of flexibility and how fuel distributors meet this requirement. You may have also heard in the news relating to California's proposed vehicle standards for greenhouse gases because it is becoming a pretty hot button issue, both at the state level and at the federal level. So if implemented California's proposed standard would mean that in 2012 new cars would have to emit 22 percent fewer greenhouse gases by 2016 cars still in the state would have to emit 30 percent less. I guess it's worth giving a quick bit of history here, so under the federal cleaner act, California has unique authority to set emissions standards for vehicles in the fair air quality standards because California actually started regulating those things prior to federal government. So California can set a substandard and then it is really a formality

but they have to submit a waiver to the federal EPA – federal EPA has to grant waivers California can go the same way. Other states can choose to follow either of the two standards, it can follow California or it can follow the federal standards. What's happened is that California proposed these standards several years ago and applied for the waiver from the EPA, the EPA has yet to grant it. But is has been a long on going process and in fact California announced earlier this year that if the EPA doesn't hurry up and say yes or no, they are going to sue them and I think it was actually just a story yesterday saying that the case will be filed next week. So that is setting up a bit of a show down again between the state and the federal EPA. This is significant because if the standards are implemented, 14 other states in addition to California will adopt them. Just this year Maryland, Florida and New Mexico all announced their intentions to do so - which would mean that the standards apply to, I think almost half the new car market in the US which is a lot of cars. And of course, the auto manufacturers are not too thrilled about this so they have filed law suits in California as well as in Vermont. The Vermont case was actually just settled against the auto manufacturers, the judge basically said states can do this and the auto makers would have to be innovative. Of course that's in appeal but it could have significant consequences for others in the law suit in California and elsewhere.

This is just a map illustrating all the states that have indicated they will adopt the standards if they (inaudible). Probably the other major collaborative effort that has emerged in the past year at the state level is the western climate initiative. Which was formed in February 2007 by five states and it since grew to include six states including Utah and two Canadian provinces so it is actually an international effort now. There are several observer states participating in the process who may opt in at some point and at this point even without counting the Canadian participants, these states are responsible for over 12 percent US emissions and are comparable to Germany which is the seventh largest emitting nation in the world. What these states are trying to do is similar to what the RGGI states are doing but a bit more ambitious. They are aiming to set up a regional target and then some sort of economy wide regional cap and trade system to help meet it. And that target was just announced in August they want to hit 15 percent below 2005 level by 2020 and the next step hopefully within the next year is to devise and implement the system that will allow them to meet that.

I am sure you have also heard about a major development in Florida just this past summer when Governor Charlie Crisp signed three climate related executive orders. I am not going to go through every thing here basically we go everything including the kitchen sink related to climate change but the order set statewide targets creating governor's advisory team to come up with a strategy for meeting these targets, adopt California's vehicle standard creates building efficiency code including a host of other measures. So it is definitely a significant turning point not just in Florida but also the southeast. So this is by no means exhaustive but this just gives a quick run down of some other major events from the past year including NC's adoption of their renewable energy standard. NC

actually has the distinction of being the 25th state to adopt this standard so the official half way point happened right here. In the past year eight states have established legislative climate commissions or executive advisory groups. A number of other states have either joined regional initiatives that target or adopted a number of other policy measures. You may remember seeing about summer of last year but it changed quite a bit. This shows all the states that have adopted targets and in many cases what's shown here for the most part are just near to mid term targets but all these states have long term projects as well. At this point there are 17 states that have adopted greenhouse gas emissions targets and seven of those targets were set just since last October. This gives you an idea of how quickly things are accelerating especially at the state level.

Question: Are those a combination of voluntary and mandatory targets?

Mr. Hogan: It's a combination of targets set for executive order and targets set through legislation. It's not necessarily clear that one is more binding than the other and the main thing with these targets is that its showing a commitment to leadership and that this is a curious issue for these states and they are committed to addressing it. I guess one thing I can say that is significant is that, I said that seven states adopted targets within the last year and all but two of those were set through legislation. So until this past year, historically most of the states have been setting targets through governor's action – executive order. But now that is changing, more and more legislatures are getting on board and really seeing this initiative tackle we are seeing more and more that bills are being enacted to set state wide targets.

This shows the 26 states plus the District of Columbia that's adopted renewable energy mandates. Illinois is the most recent, NC was just before that. So it is pretty amazing that there are now over half the states – well over half the population – has the renewable energy mandates of some sort. And of course they range across a large degree in terms of ambition in large part that is due to the resources available to an individual state. So some targets are pretty ambitious, 25 percent by 2025 and others more moderate but none the less it's a pretty interesting map to look at potentially given the debate on the hill in DC about a proposed RPS for in entire nation.

I am not going to go through all these in great detail but this just shows some of the collaborative effort that states are participating in. You can see the western climate initiative in the west, northeastern states participating in RGGI, many of these other efforts such as the Western Governor's Association are not looking at climate change directly necessarily but are looking at definitely related issues especially energy production. I guess one such major collaborative effort among at this point almost 40 states is the climate registry. So this is an effort to develop a common system for reporting, tracking and verifying greenhouse gas emissions and greenhouse gas emissions reduction. The platform that these states are working to develop would be (inaudible) to voluntary programs or

mandatory programs but really could lay the foundation for impending federal policy because before you can reduce greenhouse gas emissions you have to be able to track them and verify where they are coming from and where they are being reduced. This is just a quick update all the states adopting climate action plans – at this point there are 36 that either have completed plans or plan in progress. I am not going to talk a lot about local initiatives, of course local initiatives matter and there's been a lot of action at the municipal and city level across the country this year. One pretty significant effort is being spear headed by the Clemson Climate Initiative. This initiative was launched about a year ago in August 2006 and aims to mobilize action in large cities around the globe by helping these cities pull their purchasing power to reduce their cost of energy, their energy use and to become more efficient. This really cumulated in the energy efficiency building retrofit program which is a collaboration between the Clemson initiative, several major global banks and energy service companies and 16 the of world's largest cities including here in the state, Chicago and New York. In these cities these partners are all going to work together to reduce energy use in municipal buildings and find ways to make these buildings much more efficient.

The last of the conclusion and then hopefully we will have time for any further questions you may have. At this point much of the world recognizes the need for serious action on climate and everybody is starting to look ahead to and think about what a post 2012 international agreement might look like. And while it is true that for a number of reasons momentum is really picking up at the federal level. It is also true that the states are way out in front of this issue and are continuing to lead on climate and are probably going to do so for a while to come. States are achieving significant in the real emission reductions while simultaneously providing models and lessons for possible federal action. And even with the feds stepping up and doing their part some national efforts of the state level are likely to continue playing a significant and key role. It really doesn't matter what happens in places like NC and other states for these reasons and others. That is it so anyone have any questions I am happy to take them.

Mr. Garrou: Questions for Mr. Hogan? Thank you.

Senator Pittenger: Mr. Hogan I appreciate your presentation. Like to ask you about the relationship to China – it seems to me that your graph did indicate that maybe the eastern part of the country was a matter of emissions but now you said verbally that it's the whole country in reality. I think I would beg to differ with you on the role of China and the perception that what we are doing related to cumulative transcends or supersedes annual impacts – I think it's flawed. China to my understanding is launching a new coal fired power plant about every nine days and has about 550 of them. I think that becomes a serious consideration if we're going to look at regulations and mandates and standards and caps in our state and around the country. Doesn't that seem irrelevant to you?

Mr. Hogan: While we absolutely think that we need to get China and India and other developing giants on board somehow, but it's important to keep in perspective where they're coming from and its unlikely if not impossible that China will adopt any sort of mandatory curve especially without the US showing leadership on this issue. We're hoping that China will bring us some sort of commitment whether or not it is absolute emissions reduction it might be a commitment to efficiency, waste reduced energy use. Due primarily to its Kyoto contribution many countries do look to the US as a leader in this issue and say that before we're on board you have to prove your commitment as well.

Senator Pittenger: I would just say in perspective, it seems to me that the US by nature of its own expression of the various states and members of congress, even the Democratic leadership that you outlined today from what I've read their contact with the Chinese, the Chinese seem to be not moved and really under-strained in their interest to pursue their economic development. These would be the use of these coal fired power plants.

Mr. Hogan: Of course the problem is this is the quintessential collective action problem. But really up until now the US and China especially has been using inaction on the part of each other as an excuse for doing nothing which benefits no one in the long run. So it is much more likely that China will come in the negotiation and think seriously about taking action, and they know this is a problem. In China they read the same scientific reports that we do, many of their cities will be especially vulnerable to potential impacts of climate change. So they know they can't afford to ignore them. But it is unlikely that they will seriously sit down and negotiate until they know that the US is a firm commitment to addressing their own emissions.

Ms. Choi: Follow up question on that. I think I read a report earlier this year Carnegie Mellon did on climate emissions and really how much that growth is driven by the US markets. It is almost likely its already occurring where goods and services are being made in China for the US market. Do you have any thoughts on how to deal with that trend? You've seen some of those proposals at the federal level on using trade rules and laws to try and address the situation, has PEW done any work on that?

Mr. Hogan: I am not sure that our international folks have addressed that specifically. But that is absolutely right a lot of products produced in China and the emissions associated with those products are parts that are being sold over here in the states. It's really statewide demanded at least in part, driving this rapid development overseas.

Mr. Profeta: If I could just speak – I was actually looking to testify in the Senate on that issue in July and we in our website have done, had our best trained lawyers do logical look at these questions and I think there are options. Both the

bills in the Senate debate right now from Bingaman and Lieberman contain the same provision which I would just characterize ask for (inaudible) pack to be negotiated but if its within five years with no pack you begin to incorporate the price of the carbon into the imports into the US from China and other uncapped countries. I would say it is a grey area of international law. We will not know until it's litigated but in the last five years the trends (inaudible) are that environmental protection through such measures are more and more permissible. I invite you to look at that report on our website that talks about the fine points of legality.

Representative Harrison: Thank you Mr. Chair and than you Mr. Hogan for your presentation. I want to follow up on the (inaudible) bill emissions case you're discussing and we've been struggling with that issue here in NC and from what I understand about 30 percent of greenhouse gas emissions come from metal sources or at least in NC maybe approximately. These states that have adopted the California standards are waiting to implement until we get the resolution on the (inaudible) standards and did the Vermont court resolve the (inaudible) standard or was that just a separate issue that Vermont implemented the California standards?

Mr. Hogan: That's a good question – there are really two (inaudible) that have to be overcome. One is getting a waiver from the federal EPA and that process is dragging on and now looks like California is going to take them to court for failing to grant the waiver. And the other is litigation on the part of the auto makers. There are at least two such cases, there's the Vermont case filed in Vermont by auto companies and then there is another case in California. The Vermont victory in favor of the states, the case has been appealed so it is still going to be tied up for a while. But if that's upheld then it's likely that the California or at least possible that the California law suit will be tossed out. They are very similar and so the judge in California might look at the previous ruling and say this has basically already been decided. It's likely that that process is going to go on for a while. At this point, the standard is supposed to kick in starting in 2009 which is coming up pretty soon. It may be that they end up being implemented but that the deadline for them will (inaudible).

Dr. Smith: Thank you. Appreciate your presentation – since we have met last and you emphasized this but I just want to reiterate it. SC has established their commission and it is moving forward. I am involved with that and its been very positive but the biggest development is in Florida and just absolutely (inaudible) to that state into a leadership position with Republican Governor Charlie Crisp taking that lead and I think some very innovative things. And they now have a similar body to our climate action team that is meeting regularly and meeting their first deadline of November 1st and we're tracking that very closely and being involved with a number of folks down there. These are all very positive developments for the south and I think they should hopefully lift NC's spirits to the leadership that the state has provided and that we will need to continue to

find leadership. One point that you brought up about the federal, I think we actually have a tremendous resource because I know that Tim and the folks at Duke have been very involved with the Lieberman/Warner bill. One aspect of that which I think everybody needs to pay very close attention to is this whole question about allocations and how they are going. The allocations are not, I would predict, going to be dealt with as they were dealt with under acid rain cap and trade, there is actually going to be a much more sophisticated regime of how to deal with it. Some of us are advocating for 100 percent option but there are various allocations that are being done and looked at and I think that debate is very well bused right now. But in our deliberations, I think one thing we should pay very, very close attention to is that there are provisions and I would like to ask Tim maybe to share with the group for states who do certain things to get these allocations. These allocations are worth serious money because the overall allocation budget may see a hundred billion dollars annually. How states receive allocations for taking early action, what is being proposed in this bill and what will be further debated in the coming months, I think is something that we need to pay very close attention to because it may help advise us on some things we want to do. Tim I was wondering if you might just share some insight that you've developed if you have a moment. I think it would be very helpful and its relevant to this particular topic.

Mr. Toben: I'm just lucky that I brought the bill with me. Does everybody understand what the allocation pool is when you create a cap and trade program on greenhouse gases you create emission allowances that you have to hold one to (inaudible) greenhouse gases? You will have to give those in SC and Georgia – well you don't have to give them (inaudible) but they should be given generous allocations. There still is some that get allocated to other people who can sell them and derive value from them. If they worth what they're worth to you right now, they're worth about $30 a ton and they can create six billion tons in the US program – that about $180 billion dollars worth of value. There is a program here overall that gives about nine percent of those credits to the state, they reward states that have taken action on the coupling, I'm making sure that the POC are adjusted to award on efficiency and that they reward states that have taken energy efficiency building standards and they reward states for taking early action in terms of creating a cap on their own emissions. The contingents are allowed at least five percent of that pool is given to the coupling efficiency investment states and two percent of the pool is given to states that are taking early action in terms of capping their own emissions. There is also another pool that goes to states generally just to have resources to adjust in the climate change. Its this one bill that most likely to move to the floor – it's an early draft though but I think the overall message is that the federal legislation is looking at states that are taking early action moving and trying to award their actions.

Mr. Garrou: Would these allocations go to the state government?

Mr. Toben: This pool would go to the government itself for their own usage and there is a long laundry list that they can use them for.

Mr. Garrou: Welcomed Representative Harrison as Co-Chair and looks forward to working with her. I would also like to apologize for being late, a big accident on 40. Now we will hear from George who will tell us about the REPS that was passed in the Legislature last session.

George Givens: As I indicated in the beginning, many of you are familiar with this and if you've already heard all you want to hear about this bill, (Exhibit E) I will not be offended if you take a little break and I'll try to keep it as entertaining as I can. You have three documents that are coming around in connection with this presentation, a copy of the bill itself in its ratified form and signed by the Governor that's Session Law 2007 397. There is also a summary (Exhibit F) which I will be using as my guide through this and a copy of the fiscal note (Exhibit G). Now the bill in its entirety is a complex bill that deals with a number of different areas. This bill by the way was sponsored by Senator Albertson, it was one the earliest bill that was introduced which is why it is numbered Senate Bill 3. There are different ways to characterize the contents of this bill, I tend to think of this bill as having five parts – it has the renewable energy and energy efficiency portfolio standard and that's where I will be spending most of my time. It also has provisions related to man size management, it has provisions related to recovery of additional cost under the annual fuel adjustment clause, it has provisions related to construction cost of base load generation, I'll be talking about that only in most general terms and then it has some tax relief provisions related to the phase out of sale taxes paid by farmers and manufacturers for electricity, pipe and natural gas and other fuels and renewable energy credits. There is also a provision in here that adjusts the public utility and electric membership cooperatives, regulatory fees, that was done both in this bill and in the budget bill so it is not an essential part of this bill.

This bill and its House companion, not identical companion, but its kindred bill in the House introduced by Representative Harrison, House Bill 77 started out as energy efficiency bills with emphasis on renewable energy portfolio standards. The background of that involves this Commission and Environmental Review Commission and goes like this. There was a proposed study in the Studies Act of 2005 a studies bill that required a study by the Utilities Commission of the feasibility of these renewable energy portfolio standards. The Studies Bill in 2005 failed of enactment – that happens with increasing regularity around here. The Studies Bill of 2007 also failed of enactment but studies will never the less be ongoing. As a result of that the Environmental Review Commission consulted with the Utilities Commission about the possibility of conducting the study. The Utilities Commission was able to accommodate that request and fund the study about three hundred thousand dollars more or less, something in that range. It seemed advisable to increase the quality of the study and basically the buying, people who would be affected to establish an advisory committee and the Utilities

Commission did that. That resulted in the preparation of a (inaudible) proposals and ultimately the Capper Associates was selected as the contractor to conduct the study. Lacapper subcontracted with GDS Associates for a study of energy efficiency as a component of the renewable portfolio standard and these reports are reports that you've seen, I think we had presentations on them and distributed them to you last year or early this year. As I said they lead to the drafting of Senate Bill 3 and House Bill 77. Senate Bill 3 was then the subject of a large stake holder process, we met either in this room or downstairs in 544 averaging 75/80 participants a meeting and we met for several months hammering out the details and adding portions to the bill to make it acceptable to various interest groups.

Turning to the renewable energy portfolio standard, first of all, it would be useful I think to talk about what is a renewable energy resource. These are defined in the bill and there is a list and I'll comment on some of these. Renewable energy resources include solar electric, or solar thermal energy, wind which we have an abundance in this state in the mountain region and the coast and then we also have an abundance of legal and political restrictions on the use of wind. Hydro-power – many people have the idea that hydropower is a much large share of the generation mix now than it really is. Hydropower is used primarily to meet peak load in demand and by most accounts all of the available hydropower resources in this state have pretty much been dealt out because of flooding large new areas of land which displaced so many people and so many other resources. Renewable energy resource also includes geo-thermal, we don't have too much of that in this state, perhaps none, ocean current or wave energy, we have a long coast, we don't have particularly high tides variation here and of course the coast are committed to other resource uses. We have biomass resources and sometimes we refer to as the Saudi Arabia of biomass and so this bill gives particular attention to biomass resources. It's an interesting list of things that's included in the definition of biomass resource, including agricultural waste, animal waste, wood waste, (inaudible) combustible residues, combustible liquid resource, combustible gas, energy crops and landfill methane. Also included in the definition of renewable energy resource are waste heat and hydrogen. Specifically excluded from the definition is peat, fossil fuels which we are told are gas and nuclear energy. So what does this bill do or what do you say about the use of those. It says that electric public utilities must achieve a generation mix that includes 12½ percent renewal resources on a phased in schedule that starts at three percent by 2012 and caps out at 12½ percent by 2021. That 12½ percent is made up basically speaking of 7½ percent renewable resources in and another 5 percent that will be derived from energy efficiency.

The LaCapper recommendation was a 10 percent renewable standard. There were folks that wanted that number to be higher, and that was the subject of a great deal of debate. The LaCapper study on which we relied indicated that the 10 percent would be doable without undue economic dislocation, in other words without excessive cost. We did feel that based on the GDS report that there was

room for an additional two and one half percent to add on to the energy efficiency component. One of the important features of this bill is that it includes everybody we didn't leave anyone out. Early in this process the electric membership cooperative and particularly the Electricities, the municipal electric power suppliers asked to be left out and they (inaudible) through the negotiation process able to stay in – they have a less aggressive schedule, their requirement caps out at 10 percent in 2018. All of our major suppliers of electricity are included. Electric public utilities which includes the investor owned utilities, we have three in this state, Duke, Progress and Dominion and the (inaudible) in the co-ops can basically meet the REPS requirements by generating electric power at new renewable energy facilities. This bill is focused on bringing new facilities on line and there are a couple exceptions to that. We made the exception for existing poultry waste and we made an exception for existing small hydros to encourage their continued use.

Another way this requirement can be met is through the use of renewable energy resource to generate electric power at a generating facility, reduce energy consumption through the implementation energy efficient measures, purchase of electric power from renew and renewable energy facility, purchase of renewable energy certificates derived from instate or out of state sources. The purchase of certificates has captured 25 percent, there is a lot of back and forth about what would or would not be constitutional under interstate commerce considerations. Most states that have adopted an REPS have included a limitation on out of state sources in order to encourage instate development and certainly those requirements are constitutional until challenged and found not to be constitutional. And we believe that because they are not enacted for economic reasons primarily but for public health and safety reasons that they would probably be sustained. We have that schedule of implementation. We have some speakers set aside for solar, for swine waste and for poultry waste. These are covered in your summary but for solar and swine waste it is two-tenths of one percent on a schedule that would cap out at 2018 and then for poultry waste it's expressed not in percentage but in terms of mega watt hours and it caps out at nine hundred thousand mega watt hours in the year 2014. So these particular set aside and there has been some discussion about those for replacing the bill in recognition of particular interest and goals and values including the environmental value of dealing with swine and poultry waste on the one hand and the desirability of encouraging solar which is probably at this point the most expensive of the renewable sources. So they represent a negotiated agreement among interested parties that reflect those values.

The bill does require that biomass combustion processes for new renewable energy facilities that deliver (inaudible) would have to reduce emissions of air pollutants to degree that it is achievable for the facility taking into account the environmental and economic impact. There is concern about the emissions from biomass facilities, there is that provision in the bill and the value of the use of biomass depends upon what you compare it with. If you compare biomass to the

most pristine source that might be available, then it perhaps compares unfavorably but if you compare it to the sources we actually have it appears to be as environmentally advantageous. The bill provides that the cost of these renewables will be recoverable by the utility through an annual rider approved by the Utilities Commission. And that rider is capped to prevent what is called rate shot. The schedule of caps is in your summary for residential customers in the period of 2008-2011 is capped at $10 per customer account per year, in other words, less than $1, it maxes out at $34 per year or a little less than $3 per month in 2015 and thereafter as a separate schedule for commercial accounts and industrial accounts.

The Utilities Commission is charged with rule making to implement the REPS, that process is underway – there is among the many instructions to the Utilities Commission a provision that provides for what is called an off ramp that authorizes the Utilities Commission to modify or delay the requirements if it determines that it is in the public interest to do so. Other noteworthy provisions that the rule making that the Utilities Commission has directed to address is to establish interconnection standards for renewable energy facilities, to re-examine the net metering issue and to ensure that renewable energy facilities that deliver power will be in substantial compliance with all federal and state laws regulations, etc for the protection of the environment and conservation and natural resources. There is also extensive reporting and analyses requirements, this is covered at the bottom of page 5 of the summary and I will not go into too great a detail about that.

Senator Clodfelter and his floor debate on this bill characterized the demand side management provision as one of the most important sleeper provisions. The demand side management is distinguished from energy efficiency in this way – energy efficiency is the process by which you get the same amount of work for less energy input. Energy efficiency occurs when you replace a 100 watt incandescent light bulb with a fluorescent light bulb that produces the equivalent amount of light but requires substantially less electricity perhaps on the order of 13 watts instead of 100 watts. The demand side management on the other hand doesn't necessarily involve any reduction in the amount of energy required to perform a task but shifts it from one time period to the other to reduce the total peak demand at any one time on the system. In general the electric providers have to meet the requirement for the last kilowatt when someone flips the switch to turn on the lights on the hottest day in August and that last kilowatt of demand is typically the most expensive so it is expedient to shift demand where possible to other time periods where demand is less. This bill provides for recovery of cost of demand side management programs through an annual rider.

There are several sections here dealing with cost recovery – there are adjustments to annual fuel cost and perhaps it would be useful to take just a moment to talk about the way electric utility rates are established. In general there are rates established by the Utilities Commission that reflect the rate base,

that's the capital investment that the utility has, and reflect a return investment against that rate base and what the rates should be are determined periodically by the Utilities Commission through what is called a general rate case, which is a proceeding that's conducted for particularly utilities we just finished one for Duke that resulted in significant adjustments.

The other component of the bill is the fuel adjustment clause – this occurs outside the general rate case and reflects the cost to the utility of fuel and allows the utility to recover the fluctuating cost which can go up or down over time of the fuel component. Senate Bill 3 expands the use of the fuel clause to provide for the recovery of costs other than fuel in particular for the cost of what are called reagents that is the chemicals necessary to make the scrubbers work. The scrubbers that in particular are required by the Clean Smokestacks Act, such reagents are among the line of limestone and so forth. There are a number of other costs that will be recoverable under the fuel adjustment charge that is being renamed as fuel and fuel related charges. You can see those at the bottom of page 6 over to page 7 of your summary.

The other component of the bill that relates to the allocation of cost has to do with allocation of cost to finance base load generation. In general base load generation is paid for under existing law in this manner. A utility that proposes to build a new coal or nuclear plant goes to Commission and gets what's called a certificate of public convenience and necessity that authorizes the construction of the plant. The utility is then responsible for going out and designing and building the plant and for financing the plant through the usual financing mechanisms. The utility does not get to recover any of its costs until the facility is determined by the Utilities Commission to be used and useful. In other words, it's placed in the service at which point cost that approved and reasonably incurred goes into what is called a rate base that is the total capital investment upon which rates are calculated. The only exception to that mechanism is what happens if the costs are so excessive that the utility experiences financial distress in which case there is a possibility for inclusions of cost before the seller actually goes on line. The problem with that mechanism is the financial distress standard means that the interest rates are likely to be higher, almost certainly be higher if the utility has to resort to that. On the other hand if they don't go into financial distress then they are faced with the long term caring cost from start to finish of the project. Those interest costs then become a significant factor that would have to be added to the rate base all at once when the plan actually comes on line increasing potential for what we locally refer to as rate shock or sticker shock when the adjusted bills come in.

What this bill provides for is a mechanism of ongoing review under which once the certificate of public convenience and necessity is obtained and construction begins and costs can be evaluated by the Utilities Commission on an ongoing review basis and those costs can be determined to be reasonable and prudently incurred if they are at that time instead of waiting for the end of the process. That

also allows for the possibility of what is called construction work in progress or whip as it is often referred to inclusion of construction costs in the rate base before the plant comes on line. There are all sorts of variations that have to be considered including cancellation of the plant, that's all included in your summary I'm not going to go into that in great detail. I would just observe as follows: the effect of this in the eyes of some folks is to make construction of coal or nuclear plants easier. It does do so in the sense that it makes it less expensive, it is not a weight lifting contest so it is not a matter of easiness it is just a matter of cost. Whether or not those plants will in fact be constructed will be debated in various forms including if the Utilities Commission in the certificate of necessity process opposes it. This bill does not prejudge that except to provide for what is hoped would be the least cost financing mechanism for rate payers should those facilities be required.

We have not opened a new base load plant in this state since Sharon Harris went on line in the late 80's. Given the projected population and economic growth it appears likely that new base load generation will be needed even if there is not economic development and no increase in population the existing facilities in some cases are getting quite old and it is probably desirable to build new facilities that would be cleaner and more efficient than some of the existing facilities that we have. There is of course the hope and the goal of this bill that traditional base load generations may not be necessary if renewables are demonstrated to be able to meet the demand and the only way to determine that is to start the process of bringing them on line which will take up back to the original goals of the bill.

The other provisions of this bill have to do with tax relief there is a phase out of the sales tax paid by farmers and manufacturers for electricity, pipe and natural gas and other fuels. That phase out occurs in 2010 and then there is a provision that establishes renewable energy tax credits for nonprofits. That's a matter of primary tax law and it's explained in your summary on page 10. The bill also contains a severability clause. One other feature of the bill is that there is a provision of the bill that deals with the possibility of a federal energy bill on the same subject. The state law says that unless the federal legislation, whenever it is enacted, pre-empts the state law that the Utilities Commission will be charged to determine which provisions are the more progressive or more stringent and implement the better provisions of state law and federal law. It remains to be seen whether there will be a federal pre-emption because of NC's actions and the action in IL, I believe this summer there are now a majority of states in the nation that have a REPS so it seems to be probably relatively unlikely that the Congress would pre-empt all the federal action that is occurring. That remains to be seen. That's the summary and I'll do my best to answer any questions.

Senator Albertson: Thank you Mr. Chairman. Just a comment and I guess everybody can understand now why all the members of the body up here love

and appreciate George. You just heard a good analysis of this bill. George you always amaze me. Thank you.

Mr. Garrou: (Can't hear anything)

Mr. Profeta: (Inaudible) provision on this issue, provisions I've talked about on allocation to the state. The pre-empt question will probably be in the federal RPS debate that's currently in conference.

Mr. Garrou: (Inaudible can't hear)

Mr. Profeta: Not (inaudible) in the record.

Representative Harrison: Actually I talked to a member of Congress staffer yesterday and he said it does not at this point.

Mr. Urlaub: Thank you Mr. Chair. I was wondering if I could ask a clarifying question of Mr. Profeta about a comment he made earlier relative to Mr. Givens' presentation. Did you mention earlier that one of the items in proposed climate legislation is that states that has decoupled their rates and could get some type of preferential allocation of carbon credits?

Mr. Profeta: Yes.

Mr. Urlaub: Because I noticed here in the summary as well of Senate Bill 3 our state Utilities Commission is asked to no later than September 1, 2008 to prepare and submit an analysis of whether rates structures, policies and measures including decoupling and place in other states should be implemented in NC.

Mr. Profeta: I would just like to clarify – there are three main proposals that you have to consider in terms of what is going to happen in federal legislation. There is the Lieberman-Warner proposal that come of out the Senate Environment Committee that will be the vehicle to the floor. There is Senator Bingaman proposal from the Energy Committee that will meet it on the floor and will have to resolve their differences and then the House Representatives (inaudible) and (inaudible) are writing their own bill on cap and trade. The Lieberman-Warner bill contains this provision on the states and it is the vehicle for the Senate right now. The Bingaman I believe has not (inaudible) nothing explicit on these issues and the Dingle bill is still a glimmer in Dingle's eyes and no one knows what it says.

Mr. Garrou: (Inaudible).

Mr. Givens: Mr. Peterson has arrived and if you're ready to go I think we will stick with the order.

Mr. Brock Nicholson: Thank you Mr. Chair. I will lead off with a few comments and then turn it over to Tom Peterson with the Center for Climate Strategies who will run through the real heart and meat of the CAPAG work. First of all a few comments here, Secretary Ross does send his regards he was here for a short while but was unable to stay but he again appreciates the work of this body and the CAPAG. I particularly want to thank those members of this body who are also very active both as work group members and as members of the CAPAG also I believe there were nine sort of joint members that has been working on both efforts certainly. As you recall, our last meeting was the 22nd of February and since then we have had actually three more CAPAG meetings. At that meeting we presented to you the first 16 recommendations which were unanimous recommendations from the CAPAG to this body and then in May and then again in June we had entertained the balance of what now is 56 measures. We often refer to 53 but we kind of sliced and diced then and we are now up to 56. We did have a meeting just last week to start the process of reviewing the report, the last decisional meeting was in fact in July and this meeting last week we are starting to meet with the CAPAG members on our report. I believe being passed around is a piece that we handed out at that meeting of the preference executive summary in Chapter 1 and Tom will refer to some of the graphics in that piece when he discusses the real heart of it. It's the piece with the globe on the front, (Exhibit I) small piece there. I will point out that this part of it and the balance of the report which is rather voluminous is on the website and available. We do have very limited number of copies available so if you would like a paper copy we have a couple of those remaining that we might be able to get you one. So if you are interested, just let us know.

One of the significant things that we will talk about and Tom will talk about specifically is great economic opportunities that many of these measures offer and that they are in fact called savings net of cost. On the advice that we got last week which is important, we will emphasize in the final report, if that is in order to realize these benefits, these savings one needs to spend money up front of course and we will provide some more emphases on that part and more information on that. You will not necessarily see that in the copy you have today because that is in fact the same copy you had last week. It is a draft copy it is not a final by any means nor is the body of the report either. I think to sort of set the stage here a little bit I want to emphasize a couple of things that we have put in the preface of this report and you should have a copy I believe inside your cover there. I'll just read a portion of this: This report contains recommendations from a voluntary stake holder advisory group on potential measures and I'll kind of back up and emphasize voluntary and again emphasize that these members put a lot of time in and a lot of effort on this and in these eight meetings and in excess I think by now that at least 80 phone calls and or meetings relative to work groups. It was quite an investment and we really do appreciate that. This advisory group came up with these recommendations of potential measures to reduce greenhouse gas emissions that are worthy of consideration by policy makers in NC. And that is part of the process we are here today about is to show

you what has been done and of course the final report with its revisions will be the actual instrument that will present those to you. The Climate Action Plan Advisory Group consisted of more than 40 volunteers from business, industry, environmental groups, academia, government and the general public. The consultant Center for Climate Strategies, CCS provided facilitation and technical analyses expertise from over 300 potential mitigation options, more than 50 were analyzed considering likely greenhouse gas reduction costs and benefits. This report is not intended to be a climate action implementation plan for NC. Such a plan will come only after state policy makers access these and other recommendations further. However the data, the results and the recommendations contained in this report provide valuable guidance for the creation of an action plan or plans for legislative, administrative, regulatory or voluntary action. I guess I wanted to site just a couple of examples, we've actually started down this road already and George summarized Senate Bill 3 which I guess is a grand example of one of the recommendations in concepts that we provided last February and that was for a REPS. The one that specifically the CAPAG was talking about was not recommended with a number in it per say but certainly the concept was recommended as were a number of other measures on energy efficiency that showed up and I believe it was Senate Bill 668 and a number of other bills which did succeed in the Legislature this last session. So I think in one sense our recommendations and recommendations of this voluntary group are showing up. Another item that I think we are very proud of and was touched on earlier a little bit in one of our crosscutting measures presented in February and that was that the state should join a multi-state registry effort. We went a step or two beyond that and we in essence joined a national one not just a multi-state one, the climate registry. In early February NC became active as one of the charter or steering committee states for development of this registry and we now serve not only as a member but on the executive committee of that registry and presently developing a general reporting protocol which will be out in about a couple of weeks for public comment. This will be in a sense the national standard for reporting into these be it business or industry, government, states, universities and so forth. This is a voluntary registry as Patrick indicated earlier but will be designed to facilitate those states that may want to have reporting by their entities to be mandatory. It's voluntary it will be third party verified so that the quality of the information in that registry, whether it's put in AZ or NC, WVA will be of the same quality. The other thing that NC is doing relative to one of the recommendations that was made to this body in February is that we have served notice on our large sources in NC that they will be reporting greenhouse gases starting in 2008 for the year 2008 as part of their normal inventory process.

The last thing I want to mention before Tom fills you in on the success of this group is a presentation you will hear from Appalachian State. You probably heard me over the course of the last year and a half - two years talk about the sense that we have that many of these measures have good economic value in their own right and that they have some jobs potential. We thought we had better

have some work done to put some quantification on those assertions and so we did as an adjunct to the CAPAG work proper and we contracted with, actually CCS has as a subcontract to Appalachian State University to run some jobs analyses on the measures that are being recommended which you will get today following Tom's presentation is a look at the preliminary results and in earnest, Appalachian I want to say that this is excellent work, these are preliminary results. There is more work to do, you are free to ask questions certainly and any advice on how the implementation should be framed from this body I think would be very welcome. It is preliminary but I think it is perceptively very good news. I think with that Tom I will turn it over to you.

Tom Peterson: Thank you Brock. About what I would do is provide a summary in the form of a series of slides and tables of the work of the CAPAG and in order to bring the Commission up to date on the progress that it has made since your last review is work in progress earlier this year and then be happy to take questions whatever your directions are there.

First thing I would like to do is just (inaudible) excuse me, it is a obviously a thick document - the technical details are in the appendices and I'll share some of that information but I just wanted you to know that you can access this information directly in report that has been provided. The very first part of the process involved the development of a preliminary inventory and forecast of emissions in NC. The slide that is posted right now is the final version that went through the deliberations of the CAPAG and involved a number of suggested modifications to either the data sources methods or assumptions that were used on the initial draft of the inventory and forecast. It was finalized by the group to incorporate all suggested changes and you can see the results of it broken down by sector. The bottom line is an increase in emissions from 1990 to 2020- that's significant and this is certainly a recurring pattern that we see in all states in the US as a continued climate emission.

To summarize the final mitigation actions recommended by the Commission they are broken down in five areas that correspond to work groups that assisted in an advisory capacity to CAPAG in terms of understanding potential options for consideration. How they might be designed, how they can and should be analyzed, etc. and the total number is 56 depending on how you count some of the sub-options. You can see the break downs by individual sector but obviously this effort was comprehensive in terms of looking at all sectors and looking at all greenhouse gases within the sector so a comprehensive process. I just note that I believe it was the last time that this group got together it considered 16 of the options that the group had come to early consensus on that we will note a little bit later on, and the remaining 40 since that last meeting have been fully developed and finalized by the CAPAG. So again the last time the Commission got together it was able to consider and endorse 16 early consensus items. There were a number of other options that were suggested by the Commission at that last meeting that were approved as well. At the end of the day, out of the 56 options

48 received what we call a unanimous consent which was no objections to final recommendation. Eight of them received what we term a super majority which was five or fewer objections. We also had a third category of consensus available which was simple majority but all of the recommendations either were unanimous consent or super majority. And just to remind the Commission we did use the formal procedure of voting by inviting objections. Where objections were identified asking for constructive alternatives that would address the various consensus allowing the group to work further to iron out potential conflicts and barriers to consensus and it was certainly successful in the vass majority of cases in terms of ironing out potential conflicts. Within the report for the eight recommended actions that received the super majority of support we do have a section which characterizes the barriers to consensus which is where you will find the rationale for the objections that were registered. But again they were at a relatively low level in terms of overall percentage.

This graph is a summary of two different assessments in an aggregate level that this group finalized. The blue line is the top line of the inventory and forecast that we saw just a couple of slides ago. This is the rate of emissions growth over time from 1990 to 2020. The green line is the level of reductions in year 2010, in 2020 an aggregate that are estimated from all 56 actions recommended by the CAPAG combined. So this is, if you will, the level of effort where achievability that is estimated from all actions together. And within the report you will find for each of the work groups in the summary chapter an explanation of how that green line was calculated because it is not a simple addition of all the actions. It takes into consideration overlapped and interactions between the recommended actions so that has been scrubbed out, if you will, and that green line is a line that is the result of the integration of all 56 actions combined. You can see that roughly the end point in 2020 of emissions were all 56 actions to be implemented and their potential for reductions realized would bring emissions back very close to 1990 levels.

This is, as you will see a little bit later, actually a relatively important index point - we see that many states and other jurisdictions are planning for both short and intermediate target years. The most common and intermediate target year is the year 2020 and it gives us a very strong basis for comparison between the efforts of different states and we now have the advantage of having bench mark for quite a few states that have undertaken comprehensive climate action plans. So we can compare the potential here in NC with others and it compares very favorably.

In the report is a lot of mass and accounting and one of the summary tables that you will find is the break down by each of the color coded sectors or work group areas and the result of quantification or the recommended actions in each of them. So we see in the first column the estimated greenhouse gas reduction potential for year 2010 and that's expressed in million metric tons carbon dioxide. The next column we see the estimated greenhouse gas production potential - a

snap shot in year 2020. The third column which is total 2007 through 2020 is the cumulative greenhouse gas production potential for that particular sector for that set of 13 years. With each of the options one of the design decisions that the group made was when that option would start, when it would stop and so the timing of the option varied just based on the will of the group. But the earliest they start is 2007 some of them may start later than that because of various legs involving implementation.

The fourth column is the net present value of the direct cost or cost savings associated with the implementation of the actions if it were to be adopted and were to be implemented based on the decisions that the work group made in terms of design and implementation mechanisms and related assumptions. The final column is a ratio that shows us the cost per ton of carbon dioxide equivalent removed. This is an important metric in climate change mitigation the cost per ton per measures and you will see a graph in a minute that profiles each of the individual options on a cost per ton basis as well as a total tonnage reduction basis. So for most of the options the group requested quantification of the environmental benefit in terms of greenhouse gas production potential as well as the direct cost in terms of the cost per ton of greenhouse gas removed for that action. In some cases quantification was not requested, educational programs would be one example, but in most cases quantification was conducted.

At the bottom of this slide we have provided a call out of the cumulative greenhouse gas emissions that would be removed between now and 2020 were all 56 options to be implemented based on the analysis that the group agreed to. We also show the cumulative cost in this case, cost savings that would be associated with the full implementation of all the 56 actions. The number is a negative because the net which is a combination of positives and negatives shows unbalance, a savings would be associated with the implementation of these actions. The details of those savings are included in some detail in the appendices of the report for each and every option. Most of what is driving the cost savings figures is energy savings that are involved with the implementation of these actions.

Appalachian State University has been asked to take a look at potential economic benefits that go above and beyond the direct cost or cost savings associated with these actions. So they will specifically address the estimation of potential job impacts, personal income, and value added. But these numbers do not include any of those potential secondary economic benefits that they will cover later today.

This is also not inconsistent in terms of results with what we've seen in a number of other states and a number of other comprehensive climate planning processes in the last few years in terms of their being a significant finding of potential cost savings that is driven by the priorities that the CAPAG and other advisory groups placed on economic performance for their selection of options. So the group

generally has wanted to find options that were high economic performers. Brock mentioned the list of 300 or so potential actions that were pulled together at the outset of the process based on actions already underway in other states as well as NC. The group added almost 60 new potential actions to that list and then went through a process of prioritizing and selecting actions for recommendations. And one of the criteria was greenhouse gas reduction potential but a second criteria that was very important was the cost or cost savings, obviously the group worked very hard to find options that performed well on both measures. The other two criteria that the group used were co-benefits and feasibility issues which played an important role.

Representative Harrison: Thank you on the net present value slide, did you say the figures there are primarily energy savings derived? Is there any factoring in there that cause the carbon emissions?

Mr. Peterson: Thank you for asking – this analysis does not modify the cost of emission in terms of their potential environmental impact. So it is not quote un-quote, a cost benefit analysis because the symmetries of that particularly mean monetization symmetrically above cost and benefit. In this case, this is a monetization of the actual cost of implementation and the environmental benefit as expressed in physical terms, the tons reduced.

I wanted to just give you a thumb nail here on the contents of the technical appendices of the report because they are the record of decision of the CAPAG in terms of actual recommendations and all of the related details. The majority of this report is in fact a technical appendix within each and every one of the 56 actions that were recommended by the CAPAG. There is a policy template we call it which is a mitigating template which is written up in whatever level of detail the CAPAG thought was necessary to capture the information that was needed to reach final agreement. Some are brief, others are long but in all cases they include a standard set of descriptors of that option that you can look at to identify the details that were behind the recommendation. It includes a description of the policy in what we hope is plain English, a description of the policy design which is the statement of the numerical goals timing in terms of target years for start and stop, a coverage of parties who actually have to implement the action and any other key features of what we call policy design. These were developed early in the process after the priorities for analysis were first developed because that is the set of parameters that we need in order to quantify both reduction potential and cost. That is the next section of the template which is the estimation of greenhouse gas reduction potential and cost or cost savings. I would like to call to your attention very specifically in blue a set of key descriptors of that work which have been important, not only in the structuring of analyses but the development of consensus behind them. We do our best to break down analysis of the actions in terms of the data sources that were used, the methods used for analyzing data, key assumptions and key uncertainties, and we do this in order to try to provide as much transparency as possible in terms of how the numbers

were developed. It is not unusual for the members of the CAPAG to want to see modifications of any one of these elements of analysis to determine what their level of sensitivity is and to bring in line the analyses with what they believe is the most realistic and appropriate approach. So a big part of this process was working for a long time with advice and assistance of the technical work groups and then decisions by the CAPAG to work on the analysis to bring it to a level that was acceptable for final decision making by the group. And you will see again quite a bit of background material in the current list of appendices there is actually another set of reference material that accompanies that that is posted on the web.

The other elements that are in the policy template for each and every one of the 56 actions that are important include a description of related policies and programs in place. All of these analyses are above and beyond business as usual so to the extent necessary. There is a notation of key business as usual policies and programs already in place to the extent that the group felt it was important. There is a notation of significant co-benefits, significant feasibility issues and for the eight actions that did not receive full consensus a description of specific barriers to consensus. We did our best to solicit feedback from the group on their specific rationale for those who did object in the eight cases where there were objections and have tried to reflect that as much as possible in a fact based format. Then finally there is a listing of the actual final levels support for the actions so I walked you through this just to help you crack the report and understand how to read through the technical appendices in each of the policy templates. Again the detail there is the reflection of the work the group felt was needed to reach final agreement.

This is a summary slide which is probably too small and other wise scripted to understand – it's contained in the final report. It is a lifting of many of the 56 recommended actions with their estimated greenhouse gas reductions and I suspect this is an accumulative number but this is a simple ranking of the scale of reductions associated with each of the individual actions. So certainly not all of these recommendations are created equal in terms of their potential to reduce emissions, we see a series of what we call big ticket items and then others that slope down but were considered none the less to be important by the group in terms of identifying a full level of effort and also bringing forward important co-benefits.

The next slide is the graphic portrayal of the cost per ton for most of the 56 actions recommended by the group. On the left you will see lines that go down or bars that go down beneath zero. These are the actions that based on the analyses of the group would actually result in a net financial savings. It is important to underscore that the net calculation involves a combination of positive costs, cost outlays combined with cost savings. The timing may be different many of these involve an initial outlay in year 1 with savings in later years. The mathematics of the calculations for each of these are found in the

technical appendices but you can see that a great many of these options result in net economic savings. I would also observe that this is a fairly consistent pattern that we see now not only in other state climate action plans but in independent research, McKenzie and Companies produced a supply very recently which is looking at very recent results of either negotiated agreements or actual implementation of greenhouse gas abatement measures. It is very clear in the literature and reflected in the work of this group that at least potentially there is a significant opportunity for economic savings for individual measures. On the right of course, we see measures that on the net resulted in a positive cost outlay. They are non the less important in terms of the achievement of the overall level of effort to reduce emissions in aggregate. I would observe here also that it is not uncommon for plans to be focused on the combination of all actions positives and negatives so that the combination taken together maximizes the economic performance rather than simply isolating measures one by one.

I have listed on the slides and the final recommendations by name for each of the actions. I will not go through them in detail now but we certainly can go through them in detail whenever if you would like. In blue I have highlighted actions that were approved by this group at its last meeting based on early consensus recommendations of the CAPAG. Quite a few in this cluster are residential-commercial-industrial; you will see that this category includes energy efficiency and conservation measures in particular. The second group that had only two early consensus items at the last meeting is the cluster we call energy supply which includes electricity and heat primarily. But this is what we call stationary source energy supply and activities that can shift to lower emitting technologies and practices.

The next cluster is transportation and land use – it turns out that I made an error when this group last got together and did not note that two of these actions actually had been identified as early consensus by the CAPAG so they were not reviewed and recommended for approval by this group, but these have all been completed since. Transportation and land use involves the combination of light duty and passenger vehicles as well as heavy duty vehicles. Freight for instance, and within the arena of passenger vehicles the three areas generically of focus are the reduction of the carbon content in fuels through renewable fuels etc. The reduction in transportation and travel demand through location efficiency and the improvement in vehicle technology or operations that reduce the carbon foot print of the actual operation of the vehicle. Those same categories apply to freight as well.

Agricultural forestry and waste included a series of potential action areas. None of these were available for consideration at the last meeting of the Commission but have since been completed and generically include a combination of bio-energy, energy recovery from waste, other forms of efficiency and waste, the conservation of forest and farmlands through protection and through improved conservation practices for working land and some technology improvement in the

operation of the farms. The final set of recommendations are what we call cost-cutting issues, they generally pertain to more than one sector and include inventory forecast, reporting registry, a series of measurement approaches designed to support actions taken at the individual sector level as well as education and outreach. And then the whole arena of adaptation to climate change to the degree to which we have climate change inevitable, adaptation to it, and then, of course the consideration of the establishment of goals by the Commission. I would just note with respect to the goal issue, one of the more important pieces of information that was developed by the CAPAG just supports considerations by this group was the quantitative analyses of the emissions reduction potential of the actions taken into consideration, cost, co-benefits, feasibility issues. These were all approved at the last meeting of the Commission with the exception that the discussion of goals is on a continued basis.

I had mentioned earlier the consistency of outcome with the CAPAG process in other state climate planning action processes in the US. Last year we did a scale up analysis through my organization of the results of plans that were available and completed at that time. It is clearly out of date because a large number of states have undertaken and many have completed plans in this calendar year. But based on the scale up analysis of the actions taken by what we call leadership states, those that have developed climate action plans, we see a potential for reducing emissions to 1990 levels. The national growth rate and emissions from 1990 to 2020 is roughly 50 percent and the collective effort of these states were it to be scaled to all 50 states would reduce emissions to 1990 levels again with the same caveats that we discussed earlier in this presentation assuming all actions were fully implemented and the estimates were accurate in terms of their actual emissions potential. This is a very significant finding in that by coincidence this matches the level of effort that is identified in the interim year of 2020 by many federal bills under consideration in Congress and it is a bench mark in terms of early action that is consistent with long term climate stabilization goals that have been recommended by many members of the scientific community and are discussed in the intergovernmental panel on climate change for the assessment report National Academy of Sciences etc. So the level of effort from the actions identified through these processes appears to be consistent with stabilization needs.

We also see a pattern that recurring potential cost savings for many of these actions that scales up at a very significant level. In the pattern that emerged in terms of the action taken in states are very consistent with what the state of NC's advisory group identified include energy efficiency and conservation which is the top wedge. Clean and renewable energy, we call that energy supply and the second wedge – transportation and land use efficiency, a very significant wedge that follows – agricultural and forestry conservation which appears to be a relatively small wedge in this diagram. But it maps the reality that much of the reductions potential in the two wedges that proceed it, energy supply and

transportation and land use are derived from bio-energy whether it's ethanol, biomass, coal fired etc. So the use of biological resources, biomass in particular for energy production is very significant in terms of the pattern. We then see outcomes in terms of reductions from waste management, industrial process emissions which are smaller but none the less important. There is another wedge that we don't include in state processes because of purely federal jurisdiction which relate to aviation emissions and those are addressed through other means but we have included them here for purposes of illustration. Again this is a scale up analysis which would suggest that based on the data that was available at the end of the last calendar year that if all US states were to pursue similar ambitious climate action plan, the US at large would be on a pathway to reductions that are very much consistent with science and policy.

Finally, I have listed most but not all of the climate action targets that have been established by states based on the results of their climate action planning processes. Some of these targets were set in advance some of them were set as a consequence of the process and the results that it yielded. What we see in type that is too small to read very easily right now is a consistent pattern where states have used an index year, typically 1990 or 2000 and then established percentage reductions against that index year at future points and time. Typically an early period of 2010/2012, an intermediate period which is typically 2020 and a few cases 2025 and a long term target which is almost universally 2050. And so we see bench marks established for early, midterm and long term greenhouse gas reductions that states have established. This list is growing as more states take action and there are a couple line items here to be determined in the case of Colorado and Montana in particular. The advisory groups in those states did make formal recommendations on goals and they are under consideration for adoption by governments in those states.

Mr. Garrou: Thank you Mr. Peterson. Questions for Mr. Peterson?

Dr. Riggs: I just want to thank you for all your efforts and a very nice presentation summary of what is a very important part of this whole climate change business – and that's stabilizing the climate. It still bothers me very much that we are not dealing with, we've got 56 items in here or sections, one called CC5 deals with adaptation. And adaptation to climate change we have, I'm told, the thirteen billion dollar a year tourist industry a large portion of which is down on the coast. One storm could take care of what you've got out there as far as your benefits and we have conflicting processes going on right now that are all short term processes that's totally ignore what's happening out there on the coast. If we don't get a handle on that the golden goose is going to go away and this deal with everything from floods and droughts which we're experiencing now, to storm impact. We have an excess of bridge that we're thinking about building out there that exceeds billion and probably a billion and a half dollars. And it's likely to be a bridge to nowhere. One summer, one storm could make that all gone and it's something that I think we have to get a handle on. I don't

see any place in your scenario here where we can adapt or plug in the protection of our present economic system and our present resource space which is absolutely crucial as we move forward in this changing system.

Mr. Peterson: Thank you and I certainly don't disagree with anything you've said. I would only note that one of the outcomes of the process which was focused on mitigation was none the less by the CAPAG to identify the need for a planning process to develop a comprehensive adaptation plan for the state and under the crosscutting issues #5 recommendations which I believe the Commission endorsed at the last meeting. It is calling for a blue ribbon commission on adaptation that will presumably tackle this issue.

Dr. Riggs: So how do we make this happen? And when can it start happening? We need to get on with it. We've been lucky this year.

Brock Nicholson: Well I think that is an excellent question and point and as Tom pointed out that was in fact one of the recommendations. I think as I said at the outset, what we provided here are options to be considered by the policy makers in the state so I would assume that it would next go to whether it's the Legislature or combination of Legislature and the regulatory process and administration.

Mr. Garrou: Is the recommendation that there be a legislative commission?

Mr. Nicholson: I don't know that we spelled it out whether it's legislative or otherwise but I would think certainly that's a logical option and perhaps this body could further consider that as one of the options. I think certainly in debating the form of commission and how it is layed out the pros and cons would be legislative or otherwise. Certainly outside of what the CAPAG specifically did certainly we can envision certain advantages of that.

Representative Underhill: Thank you Mr. Chairman. I would just like to strongly endorse Dr. Riggs' statement. This is extremely important to those of us in the eastern part of the state. I certainly concur with all of your recommendations but we are ignoring a major vulnerability that we must address whether it's a blue ribbon commission, legislative commission. I don't care what kind of commission it is but we have got to get a handle on this particular problem. The sea level rise is going to doom a large sector of our economy in eastern NC and the state if we don't do something quickly. People will be displaced and it is very crucial that we address it sooner rather than later. Thank you.

Mr. Peterson: Other states are now actually developing adaptation processes and in some cases in parallel with the mitigation process, the state of MD for instance. So we are certainly seeing this, I think headed toward becoming the norm.

Mr. Nicholson: If I might very quickly add, the department and the division certainly are committed to assisting and developing such a program where we could do that.

Senator Pittenger: Thank you. Mr. Peterson I just want to clarify your response to Chair Harrison and I haven't read all of the 56 recommendations and action points. Is there a cost benefit analyses in these proposals?

Mr. Peterson: There is an economic assessment of the cost of implementation for each of the actions, the cost of removing greenhouse gases from the atmosphere for each so it is the development of information for a cost per ton of each of the actions.

Senator Pittenger: Then it does not include a cost benefit analyses for those proposals?

Mr. Peterson: This analyses and to my knowledge, no analyses other than some emerging work, the Stern report for instance have not used a monetized value for the avoidance of climate risk, so we did not attempt to monetize that because we are not aware of standard cost figures that we could use for that. So instead this is structured more as a cost effectiveness analyses to address risk reduction objectives.

Senator Pittenger: Follow-up? How many economists are with you on your center?

Mr. Peterson: Quite a few, including myself.

Senator Pittenger: Let me ask you this, in terms of your funding groups, Z Smith Reynolds, Rockefellers, have they been pretty aggressive in terms of this issue, is that shared bias that you have or is that a concern that it should be of some folks who are looking for an objective analyses. People pretty much have been on the front center who have funded your efforts in creating an urgency in this issue and it is totally anthropogenic cause.

Mr. Peterson: The work that we did in support of this process that was funded jointly by the state for DNER and private funders that have provided cost share was structured to support the specific purpose and goals that were established by DNER for the process. So our task was to support that purpose and the set of goals that were established in this process and that was the basis upon which the state and other funders have provided our organization support in terms of meeting the objectives that were layed out by the state in this process. As we have brought cost share from private funders to this effort, by the way, we are extremely grateful to the Z Smith Reynolds Foundation and to others who have assisted. The role of private donors in public policy in this country simply cannot be overstated in terms of the importance of picking up the slack or resources that

simply do not exist in the public sector quite often. But let me just say that in structuring those agreements we do not allow any contingent outcomes. So there is no agreement and we would prohibit any agreement that would specify any particular policy outcomes or other decisions that would be made by the process. The investment that they make is based solely and strictly on the process that we have been asked to manage by the state.

Mr. Profeta: I would just like to go back to where Dr. Riggs and Representative Underhill were and there was a comment that either Tom or Brock made at the very end of that conversation saying that a lot of other states had already created processes to address it. Is there any way that we could benefit from those other state's actions so that we don't have to start from scratch but we can actually take some wisdom from what they've done already?

Mr. Peterson: I think the states that are really hammering out the most current and comprehensive approach is the state of Maryland. We are conducting concurrent processes in MD for adaptation and mitigation and those are already being picked up by other states. So I would say yes, I would point to that as a primary example that you could use.

Mr. Toben: Thank you Mr. Chair. I am on the same line learning from the work of others. It has been a great deal of work in the last year or so on carbon dioxide and the carbon market both in the US and abroad. And Duke University through the Nicholas Institute has been involved in the net process and I would recommend and support a session within our next meeting that might more specifically address that opportunity as it relates to NC proper. There is a lot of data that has been developed over the last year or so that I think might give us some insight into how a carbon market cap and trade system might benefit the state. Thank you.

Representative Thomas: Thank you Mr. Chair. I sort of have a statement and a question here at the same time. I guess most politicians do that. I'm new to this group but it occurs to me that much like my mother asked me when I was in fourth grade, why would a person ever need a computer. She didn't understand that perhaps one day individual people might want to use computers. It was viewed as a business tool only. I think we all know now that everyone does use a computer and people can need them. I think that there is another point here to look at and that is where is the final solution, where do we find the final solution? And the final solution is a relatively unlimited supply of clean energy and we can talk about all the mitigating circumstances that we want, the economic impact of this or that, but in reality whoever solves that be it an individual, government entity, a university, a group of folks, they are going to print money. They are going to make a ton of money. It will make the Alaskan economy with the pipeline look like some sort of lemonade stand. I would really like to see us come up with something that helps direct some energy and effort towards the ultimate solution. We talk a lot about the negatives and the bad things that are

happening but if we can put a man on the moon and we can solve the Manhattan project and we can rid the world of smallpox, somewhere out there is a technological solution to this issue. And it is not just simply local abatement and we have a golden opportunity as a state, particularly in my region of western NC to seize that economic and environmental initiative and get them working together as opposed to having two diametrically opposed groups that are saying we are here to defend the economy and we are going to have to oppose the environmental initiatives and vice versa. There is an opportunity here for us to work together to direct both state and private resources towards a solution that really would have profound economic impact for all of our citizens. So if there are any suggestions in that positive manner I would love to hear them from any of our presenters. Thank you.

Dr. Phaneuf: Thank you. I would like to bring our discussion back to the economics a little bit if I could. So you suggested on a number of occasions the idea of negative cost and you were fairly clear in answering that indeed didn't consider the benefits. So we are talking about a negative cost estimate in the analyses? You talked also about consensus among groups throughout the country that these negative costs might emerge from these types of actions. I am an economist an environmental economists and I think I say with some confidence that there is a consensus among professional economists that you can end up with negative costs from these types of regulatory interventions. And I would just like you to address that sort of contradiction because I think that the consensus of mainstream economics is as strong as the consensus of mainstream science for warming is from human intervention. So to suggest that there are negative costs does this just sort of go against the consensus of science and if we are going to do that I think there has to be a response or reason for that and I'll listen to your response if I could.

Mr. Peterson: Well the report that the CAPAG developed and the reports and recommendations by other advisory groups across the US which include a great number of economists, whether they are mainstream or not I'll let them speak to themselves, have been developed through a technical consensus building process that has examined all of the elements of analyses that they felt were necessary to reach an agreement in terms of moving forward with a recommendation. And it has involved the participation of practitioners from various industries or organizations that would be involved and have been involved in actual implementation as well as other analyst. So these have been diverse groups. They have gone through a process using direct analyses and data or accessing other studies and then reforming and revising them based on what they think are more realistic assumptions to provide these results. The data tells a different story than whatever portion of the economic community may add a theoretical level think that negative costs are not possible. I would observe that a number of businesses that have undertaken action, some of them very large businesses discovered that they also could achieve very significant cost savings by focusing for the first time in their business operations on greenhouse gas

emissions. The consequence of that has been to identify new opportunities that there may not have been an adequate incentive to identify before and the net result of that has been actual after the fact savings. So I think that the consensus that I referred to is a consensus of negotiated agreements and recommendations that have come out of these participatory exercises. I would note that again a number of economists have been involved in these exercises and a number who I think are fairly well recognized have been involved in assessments that have been noted that our energy prices in the US today are high. They are likely to increase and for various reasons many of which are related to institutional barriers, we may not be achieving the level of energy efficiency and conservation that market forces alone would drive. I think what's behind many of these recommendations is an opportunity to bring down barriers so that the markets themselves can correct and go back and chase these incentives. So there is perhaps the market failure.

Dr. Phaneuf: Yes (inaudible) that material it is just that it really is a red hair, I mean when people like me who are trained to speak about these things and hear about negative costs immediately it doesn't sound credible. I think if these recommendations are to go forward I think that we need to come to terms with that because that will be the reaction among even the most liberal environmentally minded mainstream economists, I think. And then we can disagree on the people and so I wouldn't mind actually the list of economists that you consulted with, I probably know several of them.

Senator Pittenger: Thank you Mr. Chair. I'm just responding to Mr. Peterson's comments regarding the business world on interest. I remember we had three different business leaders come here, Mr. Key who is Sr. Vice President of Bank of America, Tom Darden, with Cherokee, and the man from DuPont, Mr. Bailey I believe, and all three of them outlined what their companies are doing as related to eliminating greenhouse gases and reducing them. Every one of them said categorically the government should not play a role in that. The free market should reign and allow technology and astrometry to work its way out of this.

Ms. Choi: Thank you. I just want to follow up on Representative Thomas' comments. We also agree that technology is essential for meeting carbon contained future and we don't believe it is just one syllable but a multiple prong approach that's going to be needed to get to where we need to be from energy production to production level goods and services. I look forward to working with you on that. We believe electricity in particular can be part of that solution and certainly we are looking at nuclear energy which is a large scale source of energy without the greenhouse gas emissions.

Mr. Urlaub: I just want to say I am glad that this issue came up because this was one of the rationale for Senate Bill 3 that recently was adopted from my organizations' perspectives. Is that when you have a base line in any project out business as usual, what the cost will be to society, to consumers, to businesses

of continuing with business as usual and then model out an alternative, sometimes we find that the alternative net long term present value and estimated annual cost are less than what business as usual would be. And that's one of the ways that I was seeing the number here. That's presented in front that's been generated by the CAPAG process was that we're talking about doing something that we don't currently intend to do at least we haven't signaled that we intend to do it by our current regulations which brings me to the point made by Senator Pittenger. I would argue that regulations very much shaped the way our institutional barriers to adapting to climate change and mitigating it and a lot of work was done this year and a lot of work is involved in these 56 recommendations to actually remove government regulations as a barrier to realizing the cost effective measures that are in these 56 recommendations. So it is a little ironic that what we are considering in many of these instances is a changing government role or reduction in government role possibly to realize cost savings. At least that is how I am seeing it.

Representative Harrison: If I can respond quickly to Dr. Riggs comment about adaptation. We had contemplated introducing legislation for the long session this past session and we thought it may conflict with this climate change commission. Although I think it probably will compliment rather than conflict. So we anticipate having something for sure in the short session. Just to give you some confidence, a lot of us are very concerned about that.

Thank you Mr. Peterson for coming I had a couple of questions clarifying – I am looking at the summary and the chart on energy supply and there are three items on their ES2, ES4 and ES6 that don't have any figures associated with them and maybe you said this at the beginning. I am just wondering if it is because it is not quantifiable or if we've already had the (inaudible) of portfolio standard that you have cap and trade in there and then the (inaudible) I just wondering what the status of those recommendations are?

Mr. Peterson: I believe you are on Page 1-13. On ES2 the shaded region is simply because underneath that umbrella there is an ABMC, a lot of print there. The group did not choose to provide a quantification of the potential impacts that either a carbon tax or a cap and trade program at the state or multi-state level in that recommendation as I recall is more qualitative in this structure as well as ES6 and (inaudible).

Representative Harrison: If I could just follow up? On the public benefit charge could you elaborate on the discussion regarding that particular issue please?

Mr. Peterson: I would like to – I am truly afraid I may not do it justice because I cannot off the top of my head remember all the details that were involved there. You might invite other members of the group who were involved in that discussion. I think certainly the public benefits charge is one of the areas where we see a positive cost outlay leading through investments to not only emissions

savings but potential economic savings. But that does involve a transfer payment and so as I recall there certainly are concerns about the level of transfer payments and then the need for finding ways for the folks who make that payment, the losers if you will, to benefit from the pool of winners and benefits that result. Those are just a couple of the many things that I recall.

Representative Harrison: Ok thank you.

Senator Pittenger: Thank you Mr. Chair I would just like to respond to my good friend Mr. Urlaub. Seems to me that if there is any consideration to impose a larger tax on energy, electricity or gas that it is certainly going to be the growth of the economy and opportunity for research and development for improved technologies. So I think that would be an (inaudible) for the government that would certainly stifle what our goals might be.

Dr. Riggs: Representative Harrison, if the last legislative session did not consider this because it would conflict with the Climate Commission that would imply to me that the Climate Commission needs to get on the stick and we have all sorts of things in the mill that are going on also in the legislature right now. Decisions that are major decisions that are very short term coastal decisions that are going to be terrible with respect to this whole adaptation business coming down the road. We don't need to start hardening our shore lines for example and I did not understand your statement I guess with respect to that.

Representative Harrison: If I can just respond. I talked to someone on the staff and other colleagues and I think we felt like this Commission had addressed adaptation, it might continue to be addressing adaptation in this interim period before the short session when we would make our final recommendations to the Legislature and that would be one reason for opposing legislation. I understand the urgency and I agree with you, I am anxious about it too.

Dr. Riggs: So when and how do we go about doing that? I put a poorly worded recommendation on the table to try to help get something going. I am not sure how we proceed.

Representative Harrison: If I can respond, I expect legislation to be introduced and I'll introduce it with Representative Underhill to establish an adaptation commission, how it is comprised, whether it is legislative, whether it is administrative or if it is highly imposed, I pledge to you that we are going to do something about that beginning in May.

Dr. Riggs: Thank you.

Brock Nicholson: I might make a couple of quick closing points. As you can see we had quite a stack of items here and a lot of considerations for future policy development perhaps through legislation and so forth. Again we are committed

to help however we may in terms of helping put that together. I will say as far as our remaining schedule I may have sort of implied that, but our intent is to finish the comment work by the CAPAG members on the report, get that finalized and then along with placing the Appalachian work at least the executive summary of the report so that it all can be together and we will get all of this finished by the end of the year. The major thick piece that many of you already have, we don't expect to change much in substance but more in just details and refinement. So that is our game plan to finish up by the end of the year. The CAPAG is in a sense still convened to be available for assistance on technical issues with the Commission at least through the early or mid part of 2008.

Mr. Garrou: We think we can finish this next session in half an hour and I am afraid if I let you go to lunch, I will not see many of you when we reconvene. So with your permission let's soldier on and see if we can finish by 1:30. The next presentation is David Ponder. I think Brock is going to introduce him.

Brock: Dr. Dennis Grady has been helping with this project and we have a graduate student, David Ponder, who has been most of the heavy lifting on this but I think Dennis will give an introduction.

Dennis Grady: Thank you co-chairs, thank you Brock. Let me be very, very brief given the lateness of the hour here. We were approached by the Division of Air Quality I am the Director of the Appalachian State University Energy Center. We were approached by the Division of Air Quality in July if we interested in taking on a project. The project basically entails taking the information that you see in the technical report from the CAPAG technical working groups running them through and then put output models that we have developed at the Energy Center that we've developed basically under contract with the State Energy Office to estimate the economic impacts of various policy alternatives for the Energy Policy Counsel. Driving the train has been my colleague, Jeff Tiller and my graduate assistant, David Ponder. I want to emphasize that what we have used here in terms of the analysis is the information that was given to use by the technical working groups that Tom just mentioned. I also want to emphasize that these are preliminary draft results they are a work in progress. We still have about five to six more weeks of analyses to do. We haven't even completed the analyses and all of the recommendations. So with that said I'll turn this over to David and he can walk through the process of the model, the assumptions and what we found.

David Ponder: Thank you Mr. Chair, Madam Chair, members of the Commission, members of the audience. My name is David Ponder. I am a graduate student studying public administration at Appalachian State University and I am happy to be here with you today and talk about the work that we have been doing. I think all of you have the slide (Exhibit H) that you will see on the screen. What we will do today is briefly talk about how the input/output models that refer to as the NC energy scenario economic impact model works. We will

talk about the selection of the CAPAG policy recommendations that you've just heard about from Tom Peterson, a work considered. We did not model all 56 of the recommendations that are presented in that report. Next I will talk about sort of how we treat the data and how that data is handled in the model and then I'll talk about some of the preliminary results and what we look forward to completing in the coming weeks.

The model that we used as Dr. Grady mentioned was developed for the NC Energy Policy Council under contract with several recognized experts in the field. It has also been peer reviewed by Dr. Adam Rhoades out of the University of Southern California and the model has served as the basis of similar reports conducted in a number of other states.

Senator Pittenger: Dr. Rhoades' PhD what is that in?

David Ponder: I believe it is in Economic Geography. Just a little bit of background on how input/output modeling works. The concept of input/output modeling was conceptualized originally by Nobel Laureate, Loffly Lantif. Dr. Lantif basically came up with this concept of how sectors of the economy relate to one another. And basically what you can do is you can look at the actual transactions that occur in the economy and then describe those relationships. And if you will, think of it as a basket of goods and services, we as consumers demand goods and services for things like groceries, transportation, utilities, health care. And in turn those industries that provide us those services demand goods and services from other sectors in the economy. The health care industry relies on the pharmaceutical industry, relies on the marketing industry, so we are all connected, if you will. What happens is as we change the relationship in the economy as we change the demand for goods and services there is a ripple effect that goes out throughout across the economy. And essentially what the model does is it measures the multiplier effect of changes in the way we conduct our investment. At the core of the model is a 39x39 economic sector matrix like I said describes the consumption and production functions of each of those sectors in the economy and those are derived from the IAP group in Minnesota which stand for Impact Analysis for Planning. It is the standard source of commercially available input/output data which is itself derived from the Bureau of Labor Statistics.

The model captures the direct/indirect and induced effect in the economy associated with changes in demand. The direct effects are those direct changes in demand. Say we build a new ethanol plant in NC, that investment creates a direct demand for construction and other goods and services. In turn the construction firm that builds the bio-ethanol plant demands goods and services from other industries and then those induced effects are the recent wages paid the laborers building the plant. What the model does is it calculates changes in total employment and I want to emphasize here that it is total employment and part-time employment. The Bureau of Labor Statistics did not collect a per hour

employment data for every sector of the economy so it is difficult to translate that into fulltime equivalents although we're doing our best to figure out a way to do that. The other thing that the model calculates is changes in income. If we are employing people in a given sector based on the average wage in that sector, what is the effect on earned income? And in turn what is the effect in terms of total value added, which is income as well as rents, royalties, profits and the IAP model captures some indirect business taxes, things like sales and excise taxes, although it says not captured income tax.

Like I said, it was not possible in the six week period that we were given to conduct this analysis to do a thorough analysis of all 56 options considered by the CAPAG group. Instead we bundled 31 policy options into 24 analyses, seven from the energy supply sector, 10 from the residential/commercial, and industrial sector, 10 from the agricultural, forest and waste sector, and four from the transportation and land planning. In aggregate, these 31 policies that we examined represent 90 percent of the greenhouse gas emissions reductions in the CAPAG process.

This is a really important slide and I think it will help explain to us how the model treats the data. As Dr. Grady said, what we did is we took the assumptions from the CAPAG working groups and sort of parsed them out into outlays, investment and energy reductions and dollar savings as a result of energy efficiency gained, typically. An outlay is just what it sounds like – the program costs something to implement, that means there is less money in your pocket and because you are spending it on something else. Your rate may go up and so therefore you're spending less money on the typical basket of goods and services. On the other hand the money that is being outlaid is being invested in other technologies. It is being invested in energy efficiency, it is being invested in clean renewal energy technologies, it is being invested in biomass and bio-fuel type technologies. So that is a positive impact to the economy. On the other hand, if we're investing in efficiency and clean renewal energy, we are not investing in conventional sources of energy. So we want to take for account the displacement of that investment and not a curse.

Additionally, you want to consider the net impact on interest payment. So if a given investment in an alternative technology yields a given gain in interest payment, you want to account for that. On the other hand, if you're not making interest payments on your conventional resources, that's a negative. So depending on the scale of the policy those interest payments are a plus or a minus.

Finally many of the policies considered by the CAPAG results in reductions and energy consumptions, because you're not spending money on utility bills that creates increased personal cash flow and on the business side of things, it increases cash flow for businesses that is freed up for other investments. And so that is typically a gain in the economy. Conversely, if you're not sending money

to the utility company, they are not realizing the benefit of that revenue until you want to take into account that as well. So what you end up with when it is all said and done is a total change in net demand for the basket of goods and services based on the policy under consideration.

Those net changes in demand are then plugged into the input/output model and generate the impact that we previously discussed - impact in terms of employment, impact in terms of income, and impact in terms of total value added. Based on preliminary findings these are some of the results. If you look at the entire study period, 2007-2020 you see a net gain of 328,738 jobs. I would not worry about the 38 because in all economic modeling there is a little give and a little take. But I think the important thing to take away here is that the trend is positive. There are particular steps of policies that tend to have more positive employment impacts particularly in the agricultural and forest industry. That's because there's a labor intensive industry and so investments in those are primarily local investments as well. So you see bigger gains in those sorts of policies.

In terms of cumulative impact on personal income it is on the order of 14 billion dollars over the study period and in terms of cumulative value added over the study period it is on the order of 20 billion dollars. Just to give you a little bit of perspective on these numbers, in the base year that we looked at which was 2004, that was the latest year data from INPLAN was available when we started this process. Total jobs in the NC economy were about five million, total income in the NC economy about 250 billion and total value added in NC on the order of 300 billion. So again we see mildly positive impact, but in terms of the scale of the economy these are not earth shattering figures.

Next I want to turn to some of the specific policies that we model so that you can see how those come out. We completed analyses that chose the energy supply options 1 is ES8 which is essentially a municipal biogas policy that call for capturing methane from wastewater facilities to generate electricity. Clearly the big blue there is what is going to capture attention. That's a combination of Senate Bill 3 that was modeled by the CAPAG group as well as some additional energy production tax credits for renewable energy and accounts for a little bit of the biomass that significant overlaps in the biomass analyses conducted by the agricultural and forestry groups and the energy supply group. So that biomass component most of that is already captured in the REPS type analyses. As a point of reference, these values are consistent with the results from the LaCappra study. There is just (inaudible) which was talked about earlier by Mr. Givens. The LaCappra study looked at a 20 percent, a five percent and I think a 10 percent and it included some energy efficiency components in there as well. The primary reason why the results are similar is we followed the same logic as the LaCappra study which is a fairly conservative assumption that the only thing that's sort of gained in the local economy is the value of construction dollars. That is a conservative assumption because more than likely you are going to

have, if you move in this type of direction you are going to see industry form, there are already (inaudible) industries, green collar industries in NC but we want to stay on the conservative side and be consistent with something that we thought you all were all familiar with.

Ms. Choi: David just real quick. Seven recommendations that you modeled were energy supply. It only shows three here, 8, 1, and 2.

Mr. Ponder: That's right. We've not completed the analyses of the advanced call policies and we've also done a PBS analyses which was energy supply option #7 and we're still trying to figure out the way to treat that because the way the CAPAG treats it, it counts all the efficiency gains in RCI2 and so we are trying to figure out what is the appropriate level of a PBS to analyze. Does that answer your question?

Ms. Choi: It's a total of seven. I don't have the complete list in front of me but in the end it is seven.

Mr. Ponder: Another perspective on those numbers is instead of looking at the jobs impact is to consider the total value added. As we talked about total value added is income plus profits, plus some indirect business taxes and again you see the general trend is toward an increase. That is because as the policy is ramped up as the REPS bill comes on line you see greater investments in renewable energy technologies. So that typically accounts for that ramping affect that you see here.

Next I want to talk about the agricultural forestry and waste options. There are a number of those options that we modeled. Clearly the ones that stand out are our policies to promote cellulosic ethanol and policies to promote the conservation of farm land and forest land, followed up by investments in bio-diesel productions. The goals for cellulosic ethanol production are fairly aggressive. My recollection is that it is a 20 percent ethanol displacing petro derived gasoline by 2020 and again you see the ramping of the policy effect. In essence, what you have to do to get that much ethanol produced in NC which is what the policy calls for, you have to build a lot of ethanol plants. So that is what you see there those construction jobs associated with building ethanol plants.

The conservation easement policy is a boom queue of households because it essentially is a cash payment, if you will, to the households and then the model assumes and goes out and spends those dollars on its typical basket of goods and services. So when we all get our tax refund check we go out and we buy that HD TV that we've been wanting all year long. So that is sort of the effect that you see there. Then the bio-diesel policy again is a fairly aggressive standard, I think it is 20 percent again by 2020 but what we're talking about is a different scale. The diesel consumption in NC is less than the gasoline consumption in NC so the impacts are less.

This is another way to take a look again at these policies and again it is important to note that some of the policies have a consistent ramp up of in total value added. But you can see that not all of the policies create total net value for the economy. The recycling policy – now that one may be a little deceiving because of the number of significant digits revealed here in the graph. But in line, per policy 13 the urban forestry measures for example while you have an initial investment in planting trees around houses, the assumption is that you only get so much energy savings from that tree planting. And by the end of the study period the costs are outweighing the benefits there.

Next I want to turn to some of the demand side related options what I refer to as residential/commercial and industrial options and what there net jobs impact are. Clearly the big job creator is funding for energy efficiency, RCI1, 2, and 11 is a combination of a public benefits fund which is I think a one percent public benefits charge and then a one and one-half percent utility revenue, dedicated one and one half percent of utility revenue to efficiency. So that's two and one half percent and that will put you well within the top ten states in the country in terms of investments and energy efficiency. Essentially what you see here and again we follow the LaCappra assumptions about how efficiency dollars are spent on a combination of purchasing retail goods and services and it is also a combination of installing the goods that you buy. So you're buying a new dryer and washer, you're buying a new heating system or air conditioner for your home but then you have to hire someone to come in and put it in. You see the gain here from both the retail sector in the economy seem to gain in spending there. The gain in construction related type jobs in installing that equipment but again the peak here, the curve comes from the energy savings. By the time the policy is fully implemented, you are getting dollar savings in your pocket and again the assumption is that you or if you were an industry, you're going to go and spend that on other goods and services as the data would suggest.

The next big gainer here is building codes. Again it is a combination of increasing investment and construction and if you think about it the constructors sector is a fairly laboring intensive secretary of the economy. But again you get sort of in the near term some construction jobs but really when you see the curve starting to come on that is where you're seeing the gain in energy savings. Because your energy bill is less, you're spending money on other goods and services in the economy. The other policies of note are the policies for combined heat and power so that is sort of an industrial and commercial level efficiency measure where your use the thermal energy associated with producing electricity to do some other things. That's again driven by investment in construction and the other policy bundle that we looked at 7 and 3, sort of what is termed as a beyond code policy and government building policy. So these are government buildings moving beyond the conventional building code standard and having a number of other commercial and residential type buildings meeting higher than the recommended energy code standard. So again you are getting

investments in construction and because you are not spending your dollars on electricity, you're spending it on other goods and services.

This slide is I think one of the most interesting slides and it really illustrates what was talked about at the beginning of the last presentation is if there are short term costs associated with implementing some of these policies. And it isn't until the long trend that you really start to see the gain. The screen is sort of smooching everything together a little bit but I think you can read from that first line. You can see that the PBS type policy you get sort of an initial rush of investments to meet other policy after a while the displaced utility investment sort of catches up and then it is not until sort of the end of the study period that the energy savings again catch up with the displacement in other investments. You can see that trend sort of consistently throughout. With just one note on RCI9 - that is a policy to encourage green power purchases by state government and so what you see there is sort of the short term investment in renewable energy, short term investment in construction jobs associated with acquiring those resources and then by the end of the study period it assumes that those facilities are already filled and then you sort of go into an operations and maintenance type mode. Then by the end of the study period you actually start to see a slight downward trend.

The next steps in the next five to six weeks include a complete and thorough betting of the assumptions that we've made and how we treated the inputs provided to use by the CAPAG facilitators and their team of professionals and economists. They have assisted me greatly so far in treating the data but like we said at the outset, these are preliminary in draft results. We want to make sure that we get this right because we understand that this is an important study and we take seriously the work that you all are doing.

We also need to complete our analysis of the transportation/land use option. We have not begun that process we're working to make sure that we're treating the data appropriately for the input/output model. We hope to initiate that work in the coming couple of weeks. And then finally, we want to complete a final report which we will make sure that each of everyone of you receives a copy of so you'll have plenty of reading to do. This will help you go to sleep a little bit faster.

Just in conclusion I want to offer some thanks to the team of CCS economists and particularly Dan Wei and Tom Peterson who have been invaluable to me in handling these data inputs and also I want to extend thanks to Skip Laitner who is now with the American Counsel for Energy Efficiency Corp. In economy Skip was the original brain child behind using input/output analyses to study the economic input impact of efficiency type policies. And then of course the team at ASU Energy Center, Jason Hoyle, Jeffry Taylor and of course Dr. Grady.

Mr. Garrou: Thank you Mr. Ponder. I take it you are also looking for input from us as to how this data might be better presented or improved. So if we have that sort of input from the Commission that would be great and also questions.

Representative Wilkins: I guess I wasn't quite prepared. Thank you Mr. Chair, I am on page 3 of the handout which would be, I'm looking at the middle frame which would is your 8 overall frame. I was out of the room very briefly and maybe I am asking for something that you've already given us. Is there a margin for error in these numbers?

Mr. Ponder. This is not a statistical sample. This is based on the data that is used to drive the model as based on the actual input/output account developed by the Bureau of Labor Statistics and Bureau of Economic Analyses. That data is treated by the INPLAN group in Minnesota to create what are called an industry by industry table. Those are the tables that describe the relationship between given sectors. So you and I for example have a particular demand for goods and services as our income changes our ability to demand those goods and services changes and so this is really an accounting method versus a statistical method. Talking about margins of error doesn't really apply.

Representative Wilkins: Mr. Chair may I follow up? I would still like a ball park guess. I don't care if it is two percent, 25 percent, 50 percent I think it is important that we know whether it's two or 50. Could that possibly come at some later point, even if it is a best guess?

Mr. Ponder: The technique involved here is a technique based on a financial accounting. The outputs that we're getting are as good as the inputs that we're given and certainly we plan on conducting sensitivity so we will manipulate some of the assumptions. Say for example, some of the financing assumptions can play an impact on the ultimate outcome of a given policy. So we will present those sorts of sensitivity analysis in the final report but they will not be margins of error. What we can do is provide the sort of, if you change this assumption, this is what happens.

Representative Wilkins: I just think some sort of guidance is important for us if we're expected to be on the ball policy makers here.

Mr. Ponder: Yes sir – we will certainly take that into consideration. Thank you.

Ms. Choi: David I raised this to you earlier and I just have a question. The INPLAN matrix is a static matrix that assumes that the cost of producing the unit of goods or services doesn't change. But it looks like a number of the recommendations would impact the cost of production for energy or for farming, food and so I am just wondering if maybe there is a better model to use to determine economic impact. (Inaudible) seems this model use for, for instance at the federal level and looking at the economic impact of some of the federal

proposals for cap and trade, I'm just wondering if there might be a different model that we could use that would take into account the dynamic changes and how you produce goods and services under these type of recommendations.

Mr. Ponder: There are a number of other types of input/output models and this is the model that we have and that we can afford, frankly. I would say this about the model and some of these dynamic issues that you raised. There are some things that we do differently in our model that typical implant modeling doesn't do. So for example, we take into account changes in labor productivity. So as labor productivity goes up you see a decline in unemployment in that given sector of the economy. So we do adjust over time for things like labor productivity, there are feedbacks for price changes in terms of fuel and we are currently working on what we call the Adam-Rhoades deflator. Which is exactly I think the point that you're getting at, which is if you have policies that increase the cost of electricity then you may have sort of a level of elasticity associated with where the consumption of electricity may go down, depending on what the price is. We are in the process of incorporating that feedback mechanism as well.

Senator Pittenger: Thank you Mr. Chair. Mr. Ponder you're here for economic analysis of your climate mitigation strategy and I do appreciate your role in terms of political scientist, public administration. I respect that but were there some environmental economists PhD trained folks who gave input in this process that were on your specific team?

Mr. Ponder: Yes absolutely. As I mentioned Dan Wei who is a PhD economist I believe her degree is again economic geography. She is also at USE (inaudible) provided a lot of help and assistance in need kind of climbing the learning curve, if you will. There has also been as I said review by the other facilitators involved in the technical working groups, Jeffry Tiller who was unable to be here, his master's dissertation was in input/output analysis and then we've also worked with Skip Laitner who is formerly of the EPA and now is at ACEEE. He is widely recognized as a pioneer in this type of analysis.

Senator Pittenger: Mr. Chair at some point I was just like to make a recommendation if we could have Dr. Ed Erickson a member of our Commission who is an environmental economist speak to us on this I think it would be great.

Dr. Eggers: Thank you and Thank you for your presentation. I am interested in the sensitivity analysis, tornado diagrams too I think that would be fascinating. This is less a question for you than a statement for the Commission and I think what this is bringing to light is something that we need to consider in our role of making recommendations. And that is these jobs are real jobs that I think will be out there, plus or minus some amount. We need to make sure people are trained to carry out these jobs. I was invited to testify before a House congressional subcommittee and small business. One of the other people

testifying, we were talking about energy issues, one of the business owners testifying said he had to go to Atlanta, he's in TN, to find a company that could give him energy efficiency lighting in his manufacturing facility. And then in TN he could not find an electrician to install it and he had to bring in an electrician from GA who is trained adequately to install it. Now in Asheville where I'm from, Asheville-Buncombe Technical Community College is trying to get funding for a pretty large scale program to help people that didn't have green collar jobs basically, electricians, plumbers, builders, and so on. And in our university and community college systems we need to be training people who have the knowledge to do this because traditionally trained folks need to be re-trained in order to really do several of these kinds of jobs well. So that is something I think as a Commission we should consider and I would also very much echo Representative Thomas' earlier statement about investments and research and thinking outside of the box. Because while we are making good progress we are talking about 1990 emission levels as if it is a great goal. But it is not the ultimate goal it is kind of like smoking three packs a day and trying to get down to two. That's a good thing but we actually need to go far further than that and that will require technologies and things that we don't currently have. So as a Commission I think we need to look at funding research to support those initiatives as well. Thank you.

Representative Harrison: Thank you Mr. Chair. Thank you for your presentation, actually I have a clarifying question on a slide. You were giving us the context of what the current situation is - I thought you said five million jobs in NC and 20 billion in accumulative income, is that correct?

Mr. Ponder: It is 250 billion in accumulative income, 304 billion in total value added. This is as of 2004 and those values are derived from the IMPLANT data center.

Mr. Givens: David when do you anticipate that you will have your final work product?

Mr. Ponder: Excellent question – our current goal is the end of November.

Mr. Garrou: We have two young women in the back who are Annie Delmedico and Lorna MacAllister who come from the Montessori School of Raleigh and they have one or two questions. Maybe each has a question. So I'll recognize them.

Ms. Delmedico: Earlier you were talking about payments, would there be any taxes that would be forward to pay for solar technology and CO_2 consumers, etc.?

Mr. Ponder: I think the way some of the policies are written they are not taxes per say. Typically what they are, are surcharges to a monthly bill that you get from the power company. So you pay an extra dollar a month or two dollars a

month on your power bill and that goes into a big pool of money. Then the power company takes the money and invests it for all of us to reduce our energy consumption.

Mr. Garrou: Were you Annie or are you Lorna? You're Annie.

Mr. Garrou: Thank you girls. Thank you, David. That was a good presentation, is there any other discussion or announcements.

Representative Underhill: Thank you Mr. Chairman. In light of several of the comments that were made earlier in this session while Tom Peterson was speaking, I would like to see if we could have a speaker from the state of MD to address our Commission about what they are doing in MD and perhaps we could get some people from MD and maybe their consultants down to talk about that.

Mr. Garrou: On the adaptation issue.

Representative Underhill: Yes whatever they are doing in MD. Thank you.

Dr. Eggers: Just a note. The payback period on the lights of that the manufacturer installed was six months.

Mr. Givens: I would just observe generally that the co-chairs and counsel are in the process of developing a plan for the work of this Commission from now until the 2008 regular session the so called short session. I am talking to various folks in connection with that and we will be talking to others over the next few weeks. If you have particular suggestions or input such as Representative Underhill's, we would be glad to have it and to factor it in our thinking. We hope to have a cohesive and meaningful plan of activity from now until this Commission is schedule to conclude which is technically the 15th of April but I think we will be working right on up until the Short Session convenes. One of the issues before the Legislature and what this Commission may well want to weight in on is what comes next in terms of not only adaptation of which Representative Harrison has spoken to and other aspects of the climate change and how that might continue to be addressed on a ongoing basis.

Mr. Garrou: I've been asked to remind you to turn in expense reports and unless there is any other business we are adjourned for the day. Thank you.

Respectfully submitted,

Representative Pricey Harrison, Co-Chair

Thelma Utley, Commission Clerk

Mr. John Garrou, Co-Chair, ~~Presiding~~

APPENDIX

Exhibit A	Visitor Registration Sheet
Exhibit B	2007-2008 Membership
Exhibit C	Agenda
Exhibit D	Update on International, Federal and US State Action on Climate Change – Patrick Hogan
Exhibit E	Session 2007 Legislative Fiscal Note
Exhibit F	NC Legislative Commission on Global Climate Change Brock Nicholson and Tom Peterson
Exhibit G	Climate Action Plan Advisory Group Recommended Mitigation Options for Controlling Greenhouse Gas Emissions
Exhibit H	Economic Impact Analysis of Bundled Climate Mitigation Options – David Ponder

VISITOR REGISTRATION SHEET

LEG. COMM ON GLOBAL CLIMATE CONTROL 10/23/07
Name of Committee Date

VISITORS: PLEASE SIGN BELOW AND RETURN TO COMMITTEE ASSISTANT

NAME	FIRM OR AGENCY
Kathy Hawkins	Progress Energy
Shana Graham	LA, Rep. Allen
Katie Hall	Pres Pro Tem's office
Rachel Leech	Pres Pro Tems office
Joan Myers	SHS
Henry Jones	Attorney Raleigh
DAREN BAKST	John Locke Foundation
Paul Chesser	"
Becki Gray	John Locke Foundation
Frank Folger	Helms Mulliss Wicker
Ryke Longest	Duke School of Law
John Schaeffer	NC Policy Watch
Fred Bone	Bone Asso
Andy McConkey	Smith Anderson
Andrew Meehan	NCAEC
Jay [illegible]	NCAEC
Matt Garnett	The Policy Group
Steve Metcalf	NC Pork Council
Sharon Miller	CUCA
Donna S. Cox	OSBM
Tommy Clark	WRC
Michael Haley	Commerce
Judy Coggins	Montessori School of Raleigh
Amie Delmedico	Montessori School of Raleigh
Lorna MacAllister	Montessori school of Raleigh
Kristin Collins	N&O
Maximilian Merrill	NCDA+CS

VISITOR REGISTRATION SHEET

LEG. COMM. ON GLOBAL CLIMATE CONTROL 10/23/07
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VISITORS: PLEASE SIGN BELOW AND RETURN TO COMMITTEE ASSISTANT

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Carol Rowe Johnson	Cape Fear Climate Action Network, cjohnson64@ec.rr.com
Jane E. G. Smith	member, Community United Church of Christ, Raleigh
Gary K. Smith Ph.D.	" " " "
Patrick Buffkin	Nelson Mullins
Albert Eckel	Corning
Larry Shirley	SEC
Russ Dubisky	IFNC
Bob FORD	NC Poultry FED - Raleigh

VISITOR REGISTRATION SHEET

Global Climate Change — 10/23/07

Name of Committee — Date

VISITORS: PLEASE SIGN BELOW AND RETURN TO COMMITTEE ASSISTANT

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KERRY NORTON	British Consulate General, Atlanta
Jordan Schrader	press
Tony Wike	NCUC - Public Staff
Dianna Jessup	NCUC - Public Staff

VISITOR REGISTRATION SHEET

10/23/07

Name of Committee | Date

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Joe McClees	McClees Consulting
KRIS CORACINI	ENVIRONMENTAL DEFENSE
Jim Kuszaj	MCIC
Ryan Peterson	NCSU
DAWN MARKARIAN	NCSU
Katelyn Dagit	NCSU
Joseph Clayton	NCSU
Anita Flintall	NCGA
Molly Diggins	Sierra Club
SHARON STRUCK	SED
Dan Frey	NCGA
DENNIS GRADY	ASU ENERGY CENTER
David Roudier	ASU Energy Center
Margaret Hartzell	Environment North Carolina
Leslie Kilcrease	Nicholas Institute Duke University
Erin Kinsey	NC Conservation Network
James DeRosa	Global Warming Initiatives
James Haven	Global Warming Initiatives
DAN CRAWFORD	Electricities of NC
KIM GARNETT	PUBLIC STAFF TO NCUC
James Southerland	DENR DAQ
Ulla Reeves	So. Alliance for Clean Energy

LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE
2007-2008

2007-2008 Membership

Session Law 2005-442, which established the Legislative Commission on Global Climate Change, provides that the Commission shall consist of 34 members. 18 of these members are appointed by the President Pro Tempore of the Senate and the Speaker of the House of Representatives as indicated below. The remaining 16 members are ex officio voting members designated as indicated on the second part of this membership list.

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AGENDA

10:00 a.m. Tuesday 23 October 2007
Room 643 Legislative Office Building

1. Call to order
   John. L. W. Garrou

2. Introductory remarks by Cochairs
   John. L. W. Garrou
   Representative Pricey Harrison

3. Report to the Commission and explanation of agenda items
   George F. Givens, Commission Counsel

4. Report on actions taken by other governmental units in the nation related to global climate change during the past year
   Patrick Hogan, Solutions Fellow
   Pew Center on Global Climate Change

5. Discussion of legislation enacted by the 2007 Regular Session of the General Assembly to provide for a renewable energy portfolio standard (REPS) for the State (Promote Renewable Energy/Baseload Generation, S.L. 2007-397 (Senate Bill 3))
   George F. Givens, Commission Counsel

6. Report on activities of the Department of Environment and Natural Resources (DENR) to develop and implement standards and plans to control emissions of carbon dioxide and other greenhouse gases:
   Discussion of recommendations considered by the Climate Action Plan Advisory Group (CAPAG) at its meeting on 16 October 2007
   Brock M. Nicholson, Deputy Director
   Division of Air Quality, Department of Environment and Natural Resources

   Tom Peterson, Executive Director
   Center for Climate Strategies

7. Presentation of draft preliminary results of a macroeconomic analysis conducted on various climate mitigation options recommended by CAPAG
   David W. Ponder, Graduate Research Assistant
   Department of Political Science/Criminal Justice, College of Arts and Sciences
   Appalachian State University

8. Commission discussion and announcements

9. Adjourn

SCHEDULE OF FUTURE MEETINGS:

The Cochairs and Counsel have established the following schedule of meetings of the Legislative Commission on Global Climate Change for the 2007-2008 Legislative Interim. All meetings are scheduled for 10:00 a.m. in Room 643 of the Legislative Office Building in Raleigh. This schedule is subject to revision.

Commission Meeting
Tuesday 4 December 2007
Wednesday 16 January 2008
[*Monday and Tuesday 11 and 12 February 2008 – Emerging Issues Forum, NC State*]
Wednesday 13 February 2008
Wednesday 5 March 2008
Wednesday 16 April 2008
Wednesday 7 May 2008

COMMISSION WEBSITE:

In order to provide public access to the materials distributed at the meetings of the Commission and to other documents related to the Commission, a website has been developed for the Commission. The website can be viewed online at the following address:

http://www.ncleg.net/gascripts/Committees/Committees.asp?sAction=ViewCommittee&sActionDetails=Non-Standing_6268

If you have comments or suggestions for ways to improve the content or format of the website, please provide these comments to Commission staff.

ADDITIONAL INFORMATION:

Persons having questions about the Commission meeting or other matters related to the Commission may contact Commission Counsel or other Commission staff at (919) 733-2578.

General Assembly of North Carolina

Legislative Commission on Global Climate Change

State Legislative Building Raleigh, North Carolina

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   Center for Climate Strategies

7. Presentation of draft preliminary results of a macroeconomic analysis conducted on various climate mitigation options recommended by CAPAG

   David W. Ponder, Graduate Research Assistant
   Department of Political Science/Criminal Justice, College of Arts and Sciences
   Appalachian State University

8. Commission discussion and announcements

9. Adjourn

SCHEDULE OF FUTURE MEETINGS:

The Cochairs and Counsel have established the following schedule of meetings of the Legislative Commission on Global Climate Change for the 2007-2008 Legislative Interim. All meetings are scheduled for 10:00 a.m. in Room 643 of the Legislative Office Building in Raleigh. This schedule is subject to revision.

Commission Meeting
Tuesday 4 December 2007
Wednesday 16 January 2008
[*Monday and Tuesday 11 and 12 February 2008 – Emerging Issues Forum, NC State*]
Wednesday 13 February 2008
Wednesday 5 March 2008
Wednesday 16 April 2008
Wednesday 7 May 2008

COMMISSION WEBSITE:

In order to provide public access to the materials distributed at the meetings of the Commission and to other documents related to the Commission, a website has been developed for the Commission. The website can be viewed online at the following address:

http://www.ncleg.net/gascripts/Committees/Committees.asp?sAction=ViewCommittee&sActionDetails=Non-Standing_6268

If you have comments or suggestions for ways to improve the content or format of the website, please provide these comments to Commission staff.

ADDITIONAL INFORMATION:

Persons having questions about the Commission meeting or other matters related to the Commission may contact Commission Counsel or other Commission staff at (919) 733-2578.

Update on International, Federal, and U.S. State Action on Climate Change

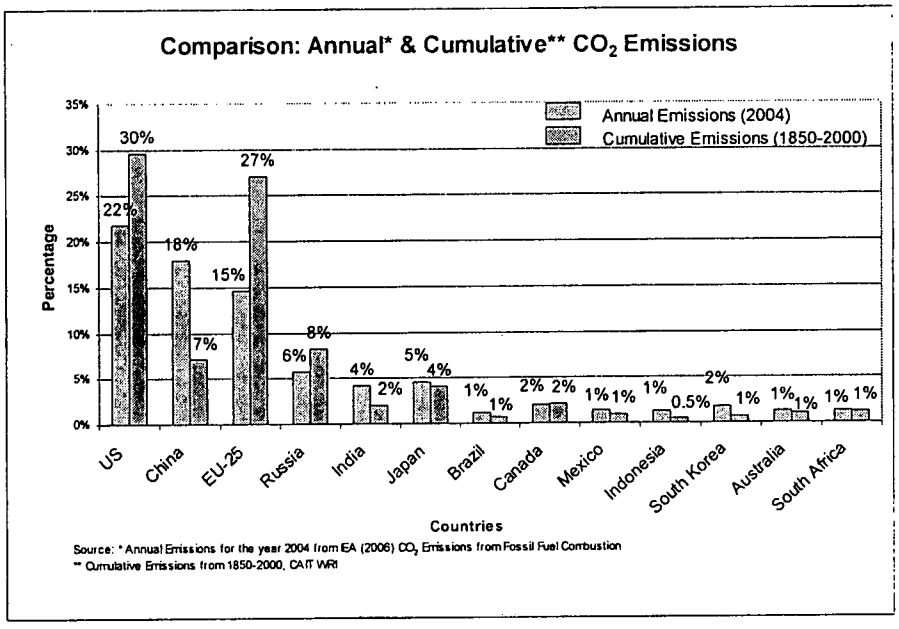
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North Carolina Legislative Commission on Climate Change
October 23rd, 2007

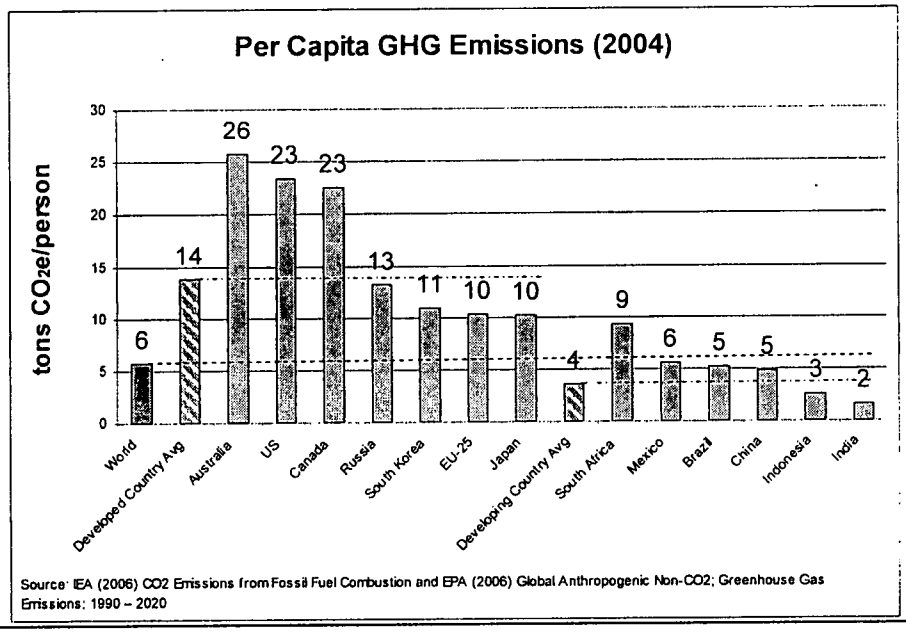
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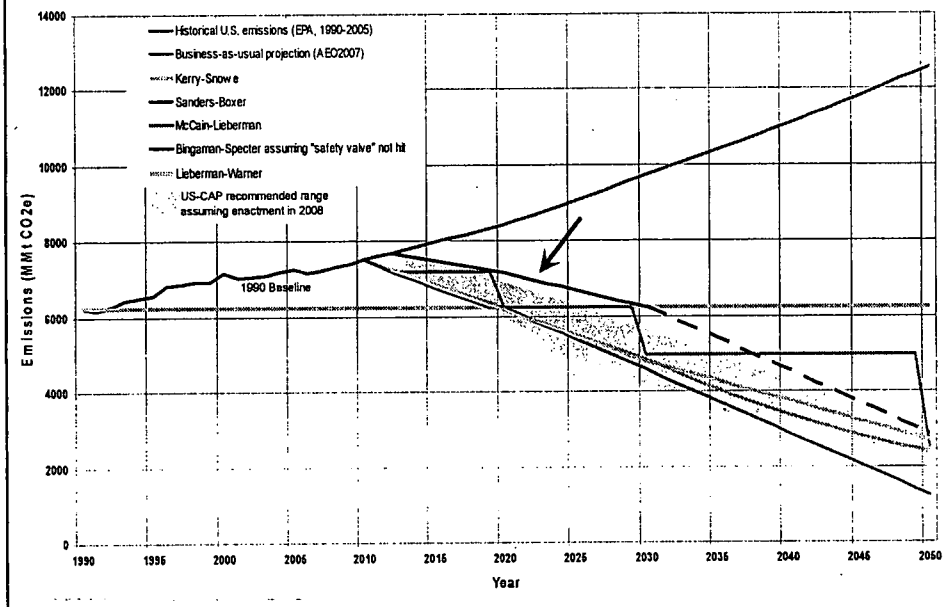
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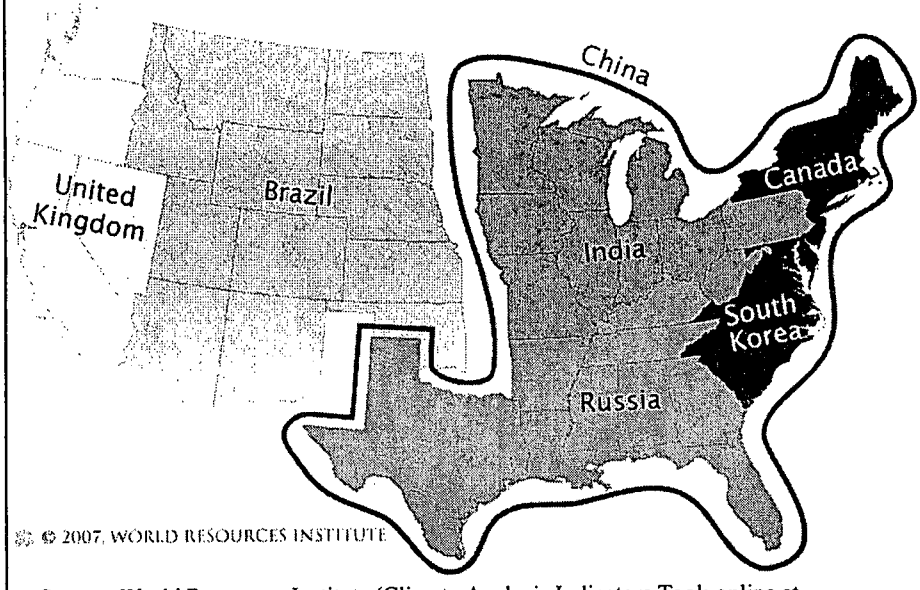
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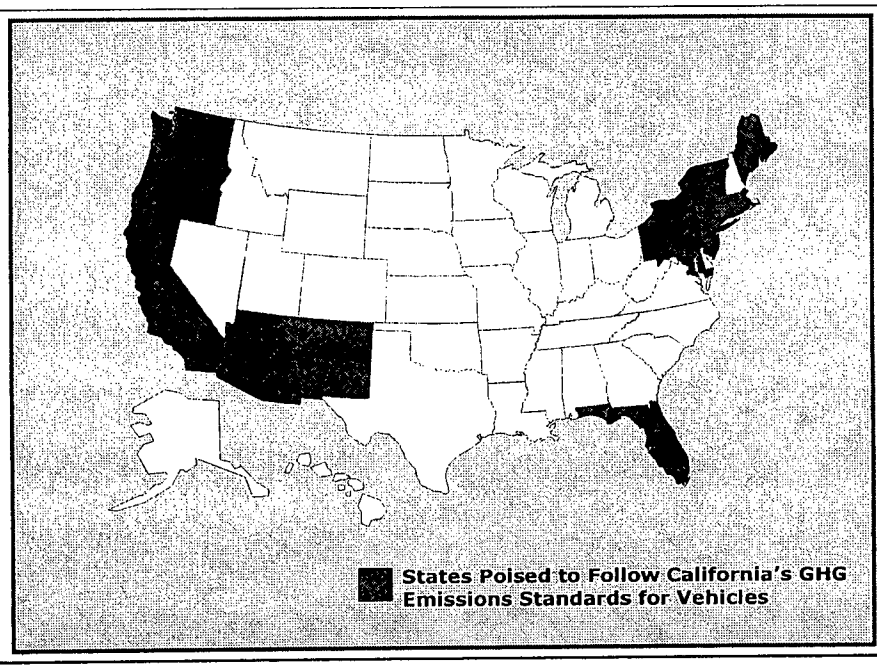


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PEW CENTER Global CLIMATE CHANGE

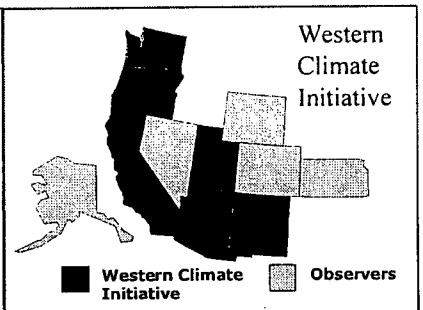
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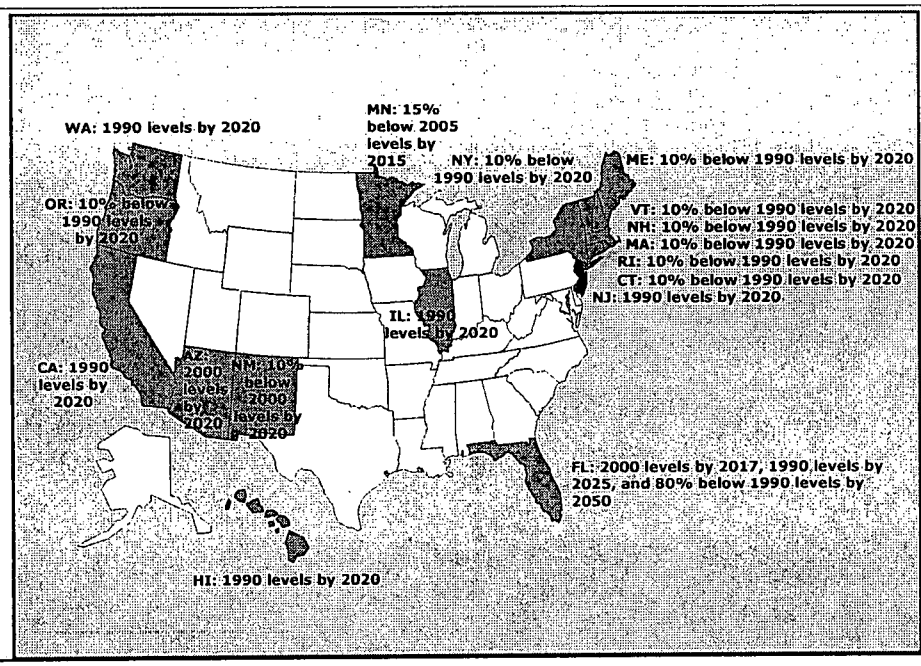
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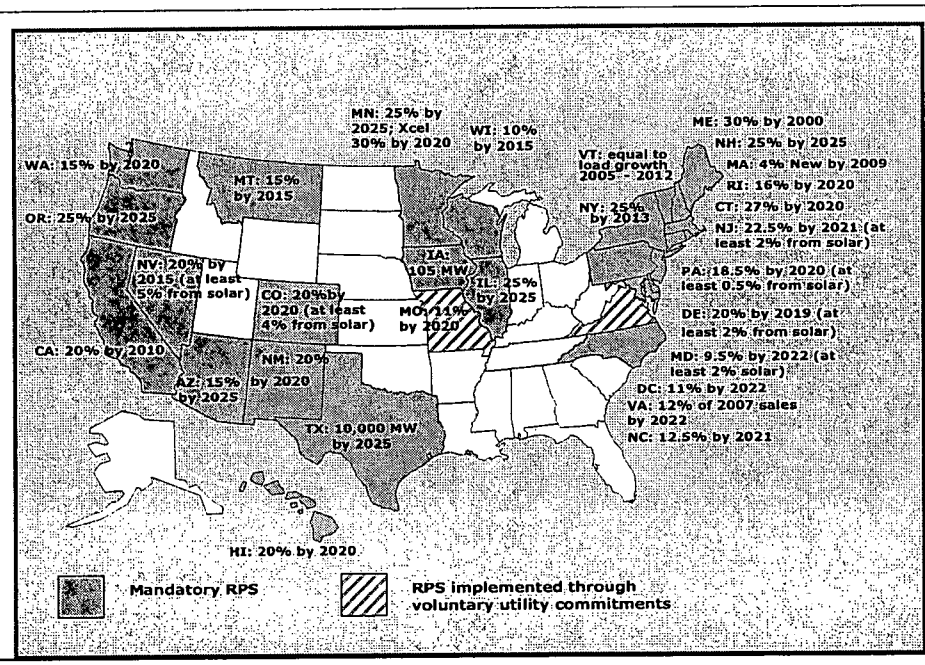
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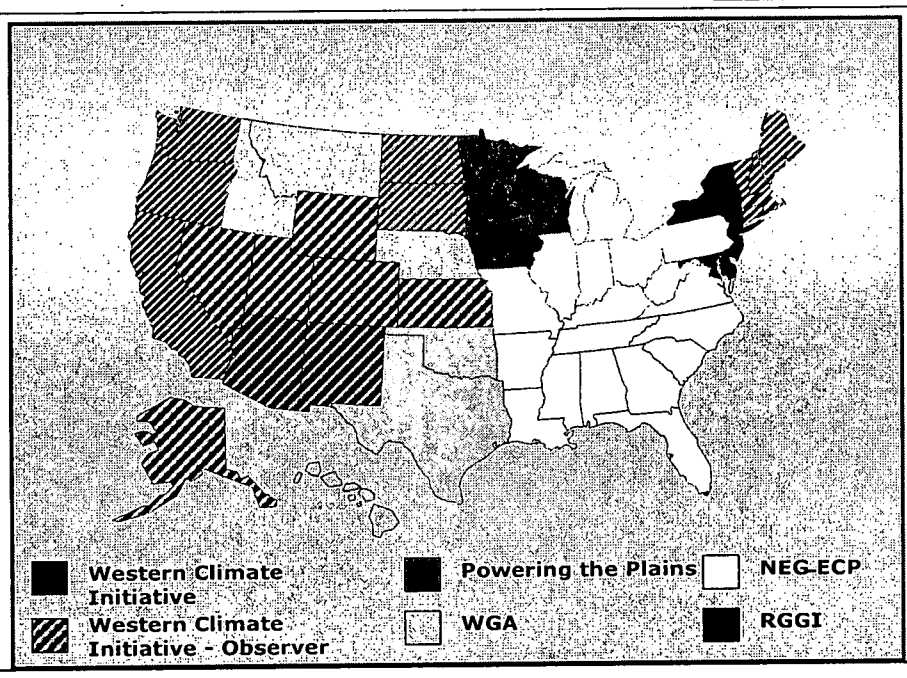


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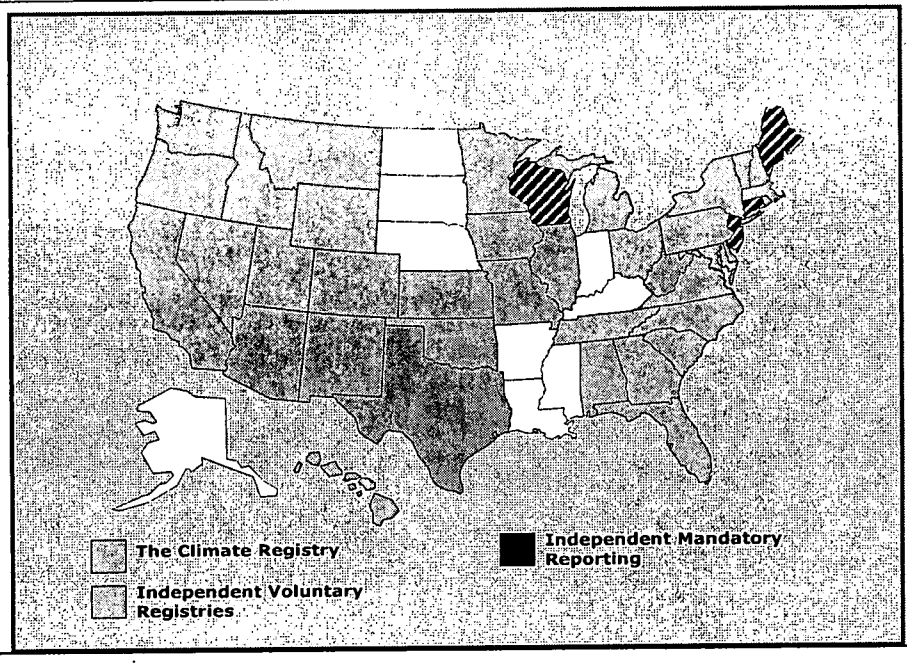
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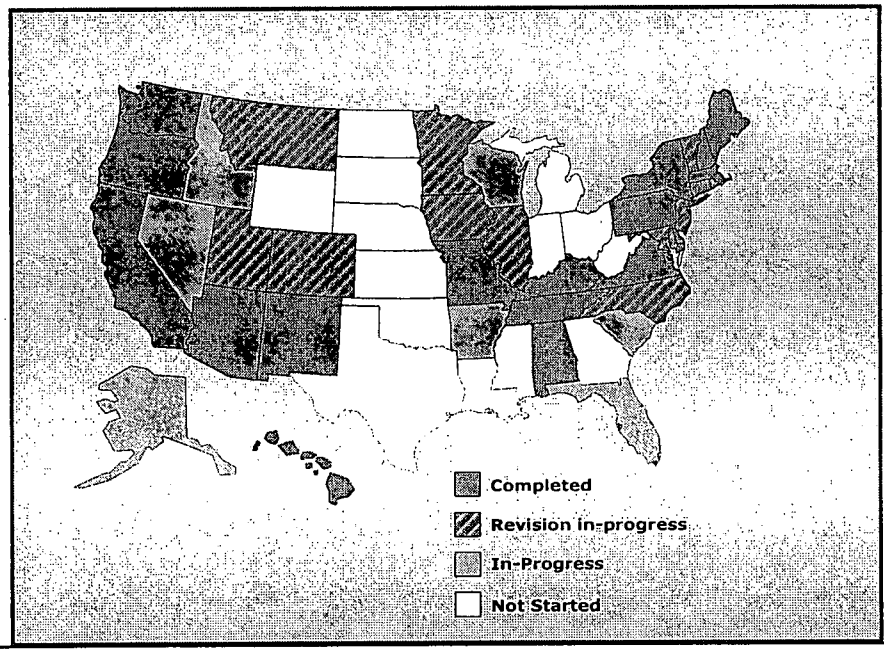
Update: Regional Initiatives



Update: GHG Reporting and Registries



Update: Climate Action Plans



Local Action: Clinton Climate Initiative

- Clinton Climate Initiative
  - Launched August 2006
  - Aims to mobilize climate action in large cities
  - Pools purchasing power of large cities to reduce the costs of energy-saving technologies and products.
  - Assistance to measure/track emissions and reductions
  - Energy Efficiency Building Retrofit program (May 2007): Clinton Climate Initiative, four multinational energy service companies, five global banks, and 16 major cities around the world working together to reduce energy use in municipal buildings.
  - U.S. cities include Chicago and New York

Conclusion

- Much of the world recognizes need for action, and looking ahead to post-2012
- Momentum is picking up at the federal level, but states are still leading on climate
- Achieving real emissions reductions
- States provide models and lessons for federal action
- Even with federal action, sub-national efforts will play a key role
- Trend toward regional action
- What happens in North Carolina – and other states – matters

Further information

Pew Center on Global Climate Change

www.pewclimate.org

hoganp@pewclimate.org

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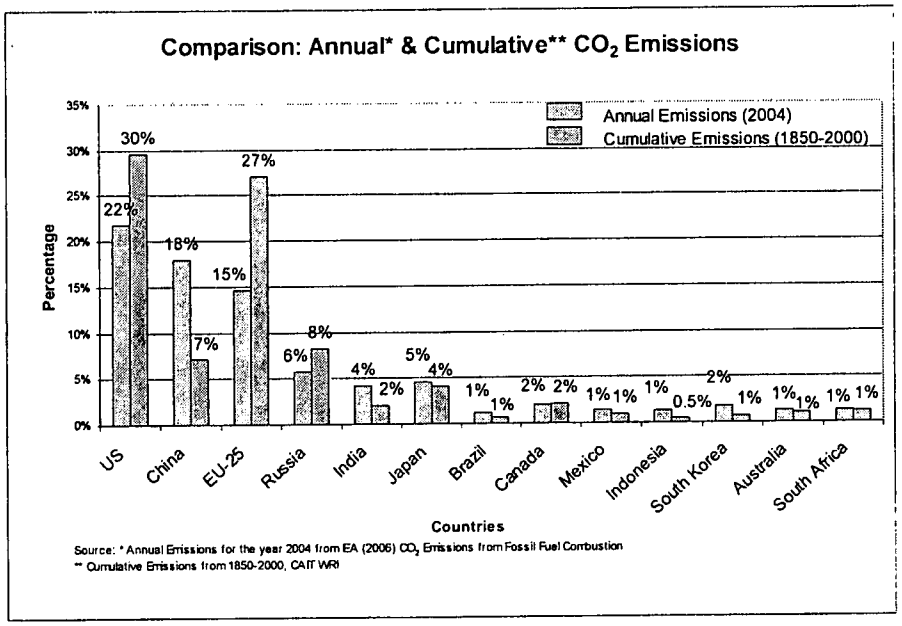
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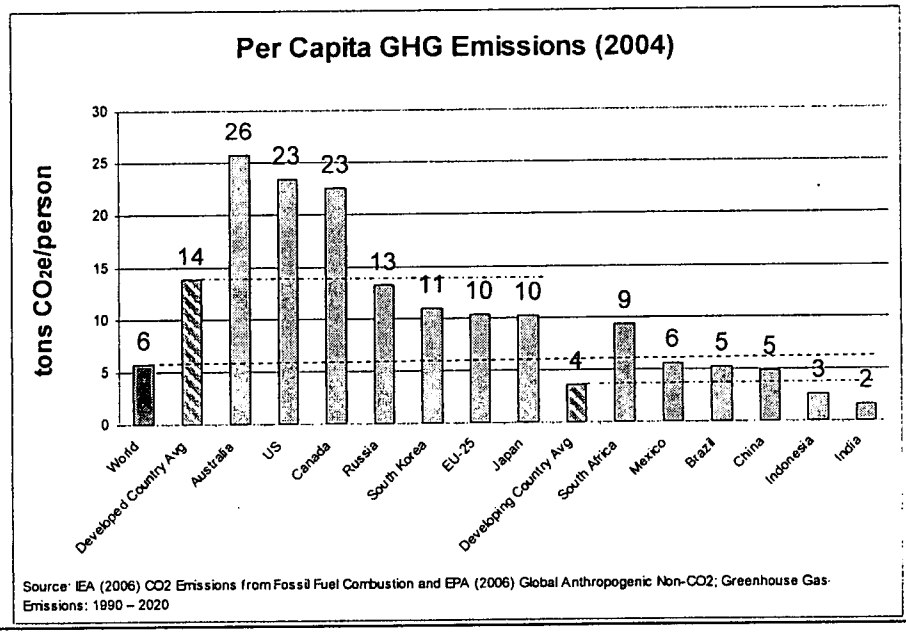
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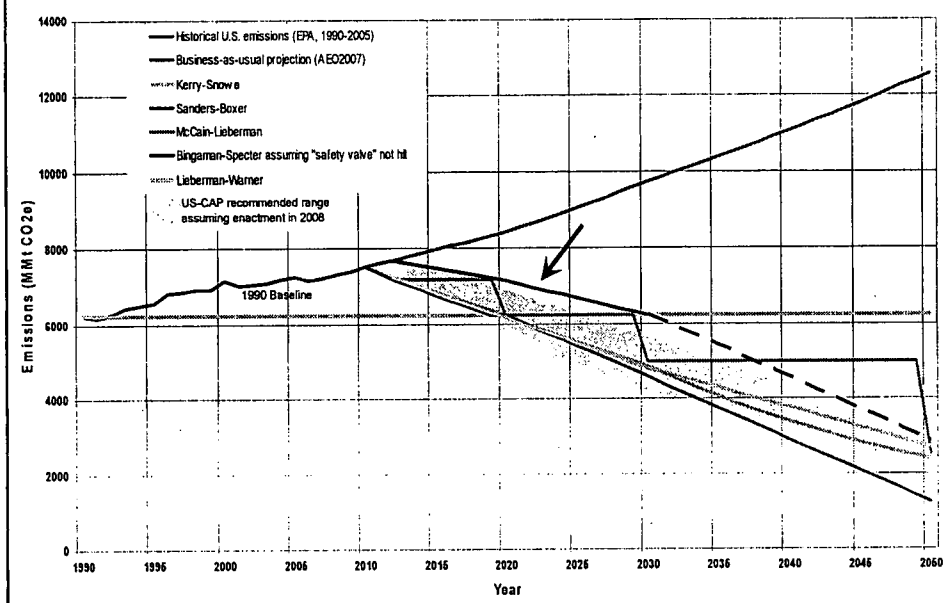
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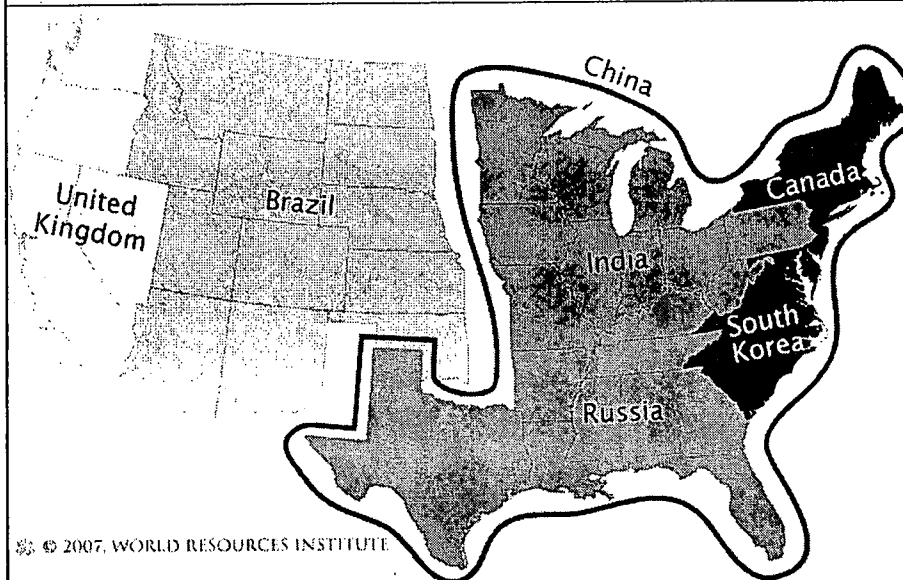
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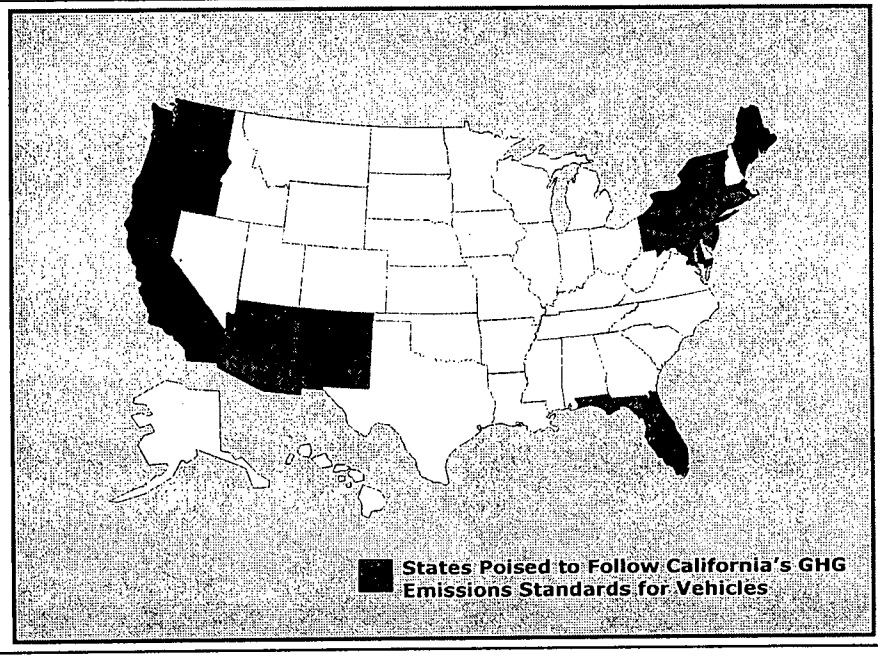


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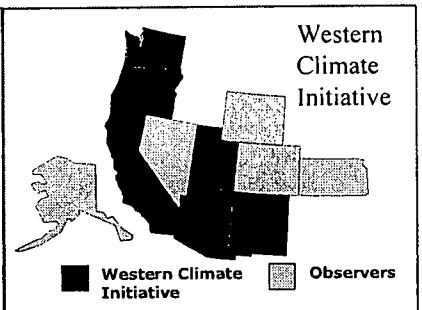
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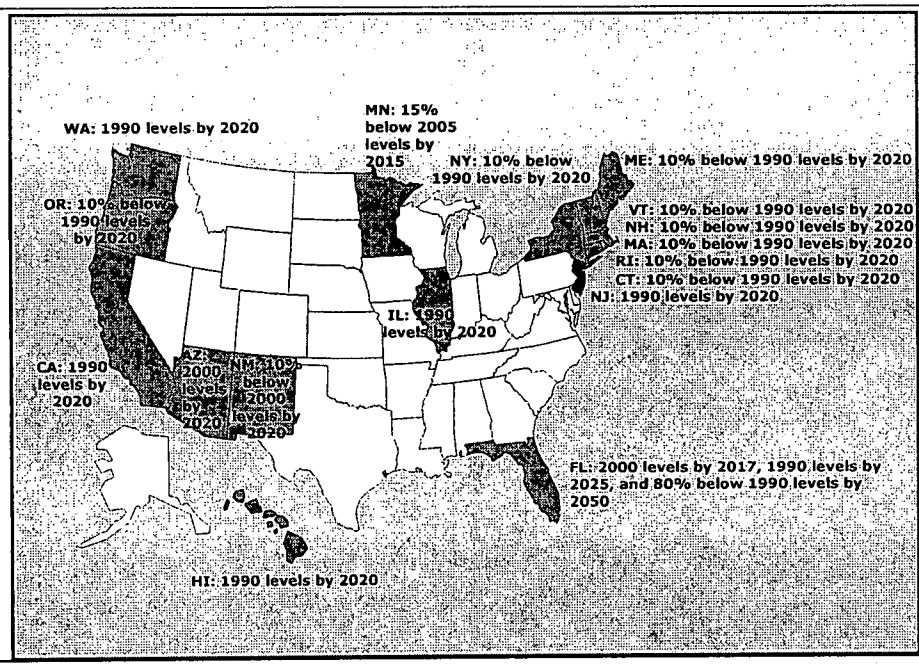
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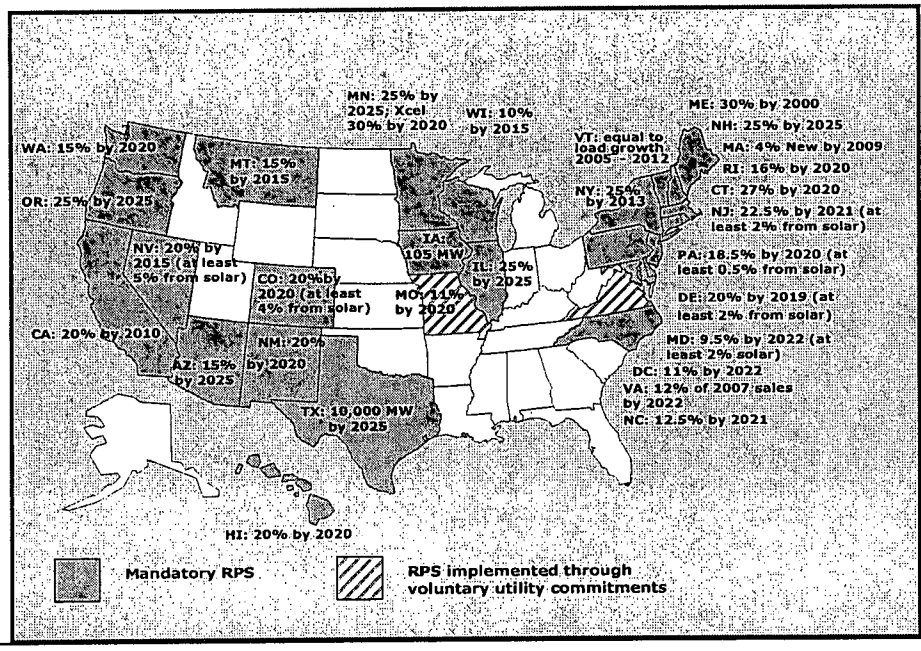
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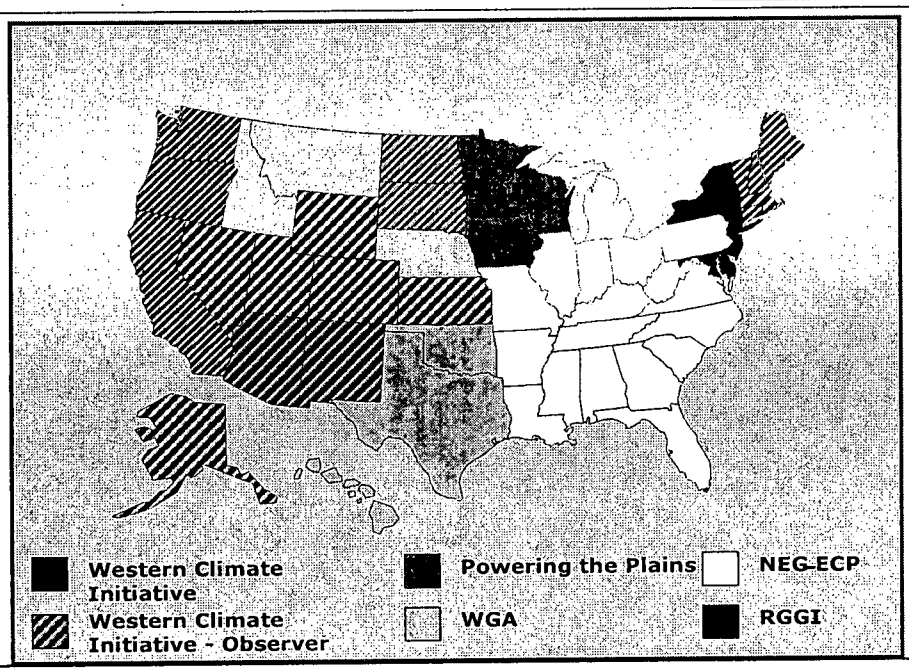
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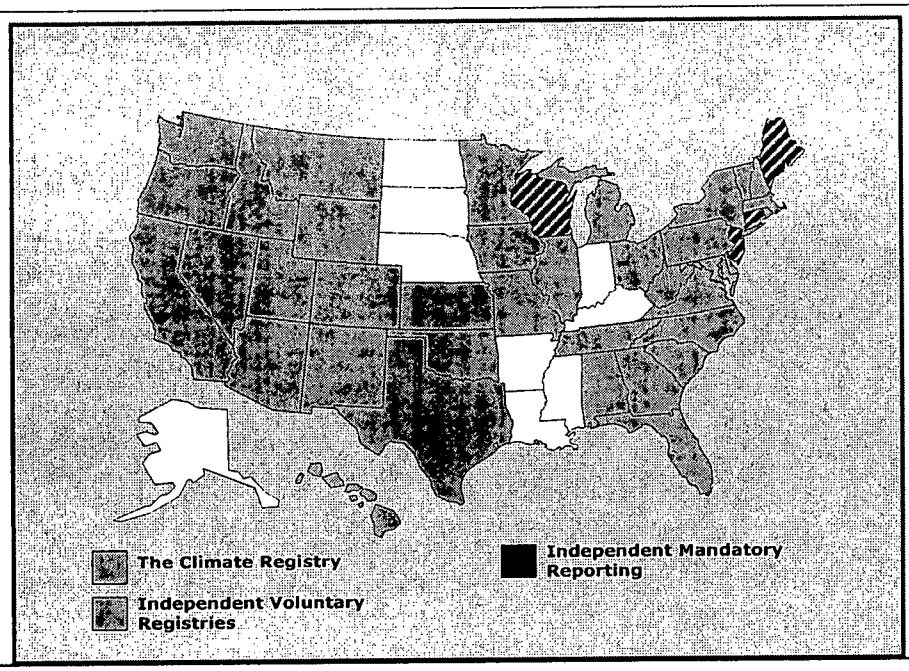
Update: Renewable Portfolio Standards



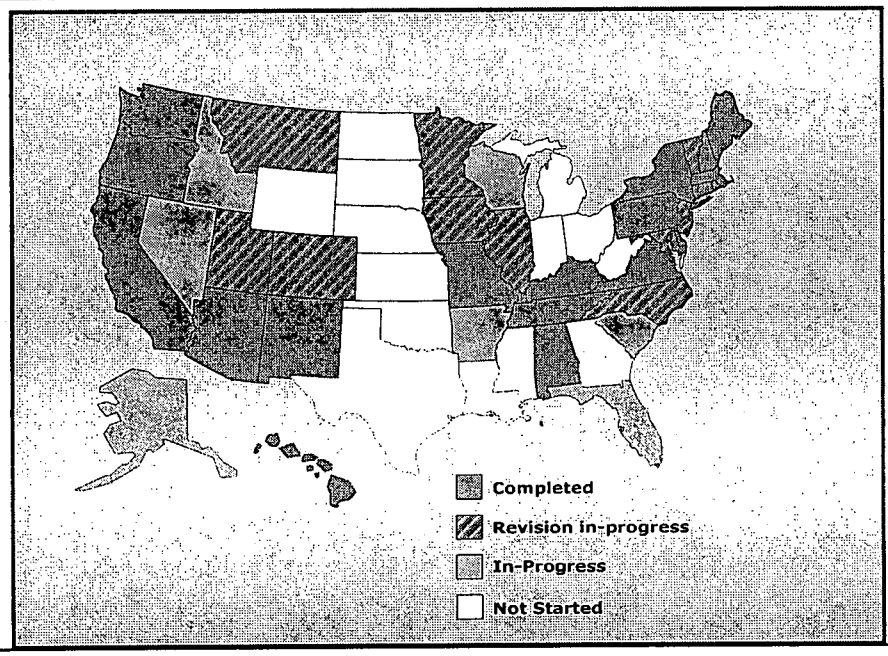
Update: Regional Initiatives



Update: GHG Reporting and Registries



Update: Climate Action Plans



Local Action: Clinton Climate Initiative

- Clinton Climate Initiative
  - Launched August 2006
  - Aims to mobilize climate action in large cities
  - Pools purchasing power of large cities to reduce the costs of energy-saving technologies and products.
  - Assistance to measure/track emissions and reductions
  - Energy Efficiency Building Retrofit program (May 2007): Clinton Climate Initiative, four multinational energy service companies, five global banks, and 16 major cities around the world working together to reduce energy use in municipal buildings.
  - U.S. cities include Chicago and New York

Conclusion

- Much of the world recognizes need for action, and looking ahead to post-2012
- Momentum is picking up at the federal level, but states are still leading on climate
- Achieving real emissions reductions
- States provide models and lessons for federal action
- Even with federal action, sub-national efforts will play a key role
- Trend toward regional action
- What happens in North Carolina – and other states – matters

Further information

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GENERAL ASSEMBLY OF NORTH CAROLINA

Session 2007

Legislative Fiscal Note

BILL NUMBER: Senate Bill 3 (Fourth Edition)

SHORT TITLE: Promote Renewable Energy/Baseload Generation.

SPONSOR(S): Senator Albertson

FISCAL IMPACT

Yes (x) **No ( )** **No Estimate Available ( )**

	FY 2007-08	FY 2008-09	FY 2009-10	FY 2010-11	FY 2011-12
REVENUES: ($ Millions)					
Sections 10-12 (State)	**($10.0)**	**($20.0)**	**($30.0)**	**($45.0)**	**($44.7)**
Section 13		**** See Assumptions and Methodology****			
Section 11 (municipalities)	**($2.0)**	**($3.8)**	**($5.4)**	**($7.6)**	**($7.0)**
EXPENDITURES:		**** See Assumptions and Methodology****			

PRINCIPAL DEPARTMENT(S) & PROGRAM(S) AFFECTED: Utilities Commission, Department of Revenue, State agencies, county and municipal governments

EFFECTIVE DATE: Sections 1,2,5,6,7, and 8 become effective January 1, 2008. Sections 3, 4, 15, 16 become effective when the bill becomes law. The effective date for Section 9 is July 1, 2007. Sections 10, 11, 12 and 13 become effective as provided in those sections.

BILL SUMMARY: Sections 1 through 4 of Senate Bill 3 establish a Renewable Energy and Energy Efficiency Portfolio Standard (REPS) in North Carolina that would include:

- A 12.5% REPS for electric public utilities.
- A 10% REPS for electric membership corporations and municipalities that sell electric power in the State.
- Provisions to encourage the use of solar energy, swine waste, and poultry waste resources.
- Provisions to encourage the implementation of demand-side management and energy efficiency programs.

Sections 5 through 9 amend the cost recovery procedures for electric power suppliers to provide for:

- Recovery of additional costs under the annual fuel charge.
- Ongoing review of construction costs and the inclusion of construction costs in rates.
- Recovery of construction costs for out-of-state electric generating facilities.
- Recovery of project development costs for nuclear facilities.
- Recovery of construction work in progress when reasonable and prudent and subject to an ongoing review by the Utilities Commission

Section 9 maintains the public utility and electric membership corporation regulatory fees at their current level.

Sections 10 through 12 phase out the sales taxes paid by farmers and manufacturers for electricity, piped natural gas, and other fuels.

Section 13 establishes renewable energy and energy efficiency tax credits.

Sections 15 is the severability clause, and Section 16 lays out the effective dates for various portions of the bill.

ASSUMPTIONS AND METHODOLOGY:

Sections 1 through 9 will be administered by the NC Utilities Commission, a receipt supported State entity. While the Commission may require additional staff in the future to administer this bill, any costs associated with that would be covered by receipts generated by the Commission.

Section 2(h)(4) allows for an annual rider to recover the incremental costs incurred by an electric company to comply with the REPS requirements. This charge cannot exceed the following per-account annual charges:

Customer Class	2008-2011	2012-2014	2015 and thereafter
Residential per account	$10.00	$12.00	$34.00
Commercial per account	$50.00	$150.00	$150.00
Industrial per account	$500.00	$1,000.00	$1,000.00

The bill directs the Utilities Commission to adopt rules regarding this annual assessment.

Government entities fall into the commercial class. To determine the maximum additional cost the State will pay, each utility company was asked to provide the number of government accounts they service, broken down by State, counties, and municipalities. Universities were included in the State number, while community colleges and local education agencies were included in the county figures. Three major electric companies serve the State: Duke Power Company, Progress Energy Carolinas, and Dominion North Carolina Power. In addition, there are 27 Electric Membership Corporations that provide power to rural areas throughout the State.

The bill does not specifically define "account"; however, in general, there is one account for every meter. Accounts may include buildings, stoplights, streetlights, etc. Progress Energy and Duke Energy both estimate that about half of their State accounts are stoplights. For the purposes of this estimate, it is assumed that the Utilities Commission will adopt rules excluding those types of accounts from the annual assessment. Therefore, only half of the State accounts reported by Progress Energy and Duke Energy are used to calculate the fiscal impact of the bill. It is unknown what portion of Dominion and co-op accounts may be stoplights, and none of the companies provided information regarding county and municipality stoplights, so no adjustment was made to those figures. To the extent that a portion of those figures are stoplight accounts, the cost estimate may be overestimated.

17 of the 27 Electric Membership Corporations responded to the request for information regarding the number of government accounts they serve. Of those, eight reported accounts by category (the others either reported one total, or provided a State number and a local number). To determine the estimated total number of government accounts for the remaining 10 co-ops, the percentage of active meters that are government accounts was calculated for each of the 17 co-ops that responded. The average of those percentages (0.47%) was then applied to the number of active meters for each of the remaining 10. To calculate the number of accounts by type for the 10 non-respondents and the nine co-ops that did not categorize their accounts, the number of accounts in each category for the eight that reported was totaled, and a percentage of the total for each category was determined. That percentage was then applied to the total number of accounts. To the extent that these calculations under- or over-estimated the number of accounts, the costs shown will be over- or under-estimated.

Estimated Government Accounts by Power Company

Company	State	County	Municipality
Duke Energy Carolinas	2,119	2,503	3,942
Progress Energy	2,014	3,073	4,080
Dominion NC Power	403	2083	
NC Assoc. of Electric Cooperatives	1325	1,485	504
Total Accounts	**5,861**	**9,144**	**8,526**
Per Account Cap on REPS Rider	$50	$50	$50
Estimated Maximum Expenditure	**$293,070**	**$457,209**	**$426,300**

Accounts included in the State category include State agencies and programs supported by the General Fund, Highway Fund, federal funds, or receipts. At this time, no data is available regarding how many of the reported accounts are agencies supported by the General Fund; therefore, no estimate is available regarding the impact of this section on General Fund appropriations. In addition, no data is immediately available delineating the accounts by county or specific municipality. Therefore, only an estimated aggregate amount for those account types is shown.

Section 5 allows for the recovery of additional costs under the annual fuel charge, not to exceed 2% of the electric company's total retail jurisdictional gross revenues for the preceding calendar year. No estimate is available regarding the potential cost of this section to government entities.

Section 10 would phase out the current sales tax rate of 2.6% on sales of electricity to manufacturing industries and manufacturing plants for use in connection with their operation and to farmers to be used by them for farming purposes as follows:

- Effective October 1, 2007, reduces the rate from 2.6% to 1.8%.
- Effective July 1, 2008, reduces the rate from 1.8% to 1.4%.
- Effective July 1, 2009, reduces the rate from 1.4% to 0.8%.
- Effective July 1, 2010, repeals the tax.

The general rate of tax on sales of electricity is 3%. Sales of electricity to an aluminum smelting facility are taxed at the rate of 1%, but this rate expires for sales made on or after October 1, 2007. Last session, in S.L. 2006-66, the tax on sales of electricity to manufacturing industries and manufacturing plants was reduced from 2.83% to 2.6%, effective July 1, 2007. This bill repeals the reduction enacted last session and replaces it with the 1.8% rate provided in this section of the bill. This rate applies to manufacturers and farmers. The rate is reduced to 1.4% effective July 1, 2008, 0.8% July 1, 2009 and eliminated effective July 1, 2010.

According to the Department of Revenue, the amount of tax collected in this category for FY 2005-06 was approximately $32.1 million. The amount of tax collected for FY 2006-07 is projected to be $32.9 million. The impact of phasing out the tax for future years is estimated by applying projected percentage changes in sales of electricity to the current amount of tax collected and prorating the amount of tax to account for the rate reduction.

According to the U.S. Energy Information Administration (EIA), sales of electricity in the industrial sector are projected to increase by 0.7% in FY 07-08. Similar increases are projected for the following four years. The projected percentage increase is applied for each year to project the amount of tax that would be exempted. This amount is then prorated by the percentage of the rate reduction for each year of the phase-out to determine the amount of sales tax on electricity that would be exempted under the bill.

Section 11 would phase out the tax imposed on piped natural gas received by a manufacturer for use in connection with the operation of the manufacturing facility and on piped natural gas received by a farmer to be used for any farming purpose, other than preparing food, heating dwellings, and other household purposes.

The excise tax on piped natural gas is based on a tiered rate structure. Rates are lower for those consumers who use a greater volume. The NC Public Utilities Commission reported that the excise tax on piped natural gas sold to large industrial customers generated approximately $18.6 million during FY 2005-06. A small additional amount of tax revenue is related to consumption by farmers. Natural gas providers were unable to provide an estimate for farming consumption, however, the amount of piped gas excise tax collected from farmers is expected to be less than $1 million annually. Projections for future years are based on EIA estimates for sales of natural gas. The projected amounts are then prorated to reflect a four-year phase-out.

Of the total amount of the piped gas tax collected, half of the tax attributable to activity within municipal boundaries is distributed to municipalities. The percentage of overall piped gas collections distributed to municipalities is approximately 40%. This analysis assumes that manufacturing facilities are located within municipal boundaries to a greater extent than other piped natural gas consumers and uses 45% as the portion distributed to municipalities.

Section 12 would phase out the privilege tax imposed on a manufacturing industry or plant that purchases fuel to operate the industry or plant by reducing the tax rate from 1% to 0.7%, effective July 1, 2007, from 0.7% to 0.5%, effective July 1, 2008, from 0.5% to 0.3%, effective July 1, 2009; the tax is repealed effective July 1, 2010.

Farmers are exempt from sales tax on purchases of fuel. Manufacturers are exempt from sales tax on fuel, but they are subject to a privilege tax equal to 1% of the sales price of the fuel. This section would phase that tax out over four years.

The NC Department of Revenue estimates that the privilege tax on manufacturing fuel generated approximately $2.3 million in FY 2005-06. Inflation estimates from Moody's Economy.com are used to estimate the change in tax revenue for future years. The impact of this tax exemption is also prorated to reflect the 4-year phase-out.

Section 13 would allow a tax credit to a taxpayer that makes an eligible contribution to a nonprofit organization organized under section 501(c)(3) of the Code. An eligible contribution is a contribution designated by the taxpayer to be used for investing in renewable energy property and used by the nonprofit organization for investing in renewable energy property. Renewable energy property includes the following machinery and equipment or real property:

- Biomass equipment that uses renewable biomass resources for biofuel production of ethanol, methanol, and biodiesel; anaerobic biogas production of methane utilizing agricultural and animal waste or garbage; or commercial thermal or electrical generation from renewable energy crops or wood waste materials. Renewable biomass resources are organic matters produced by terrestrial and aquatic plants and animals, such as standing vegetation, forestry and agricultural residues, landfill wastes, and animal wastes.
- Hydroelectric generators
- Solar energy equipment
- Wind equipment

The amount of the credit would be equal to a portion of the credit for investing in renewable energy property that the nonprofit organization would be allowed if the nonprofit organization was subject to tax. The amount of the credit for investing in renewable energy property is 35% of the cost of the property placed in service. The credit must be taken in five equal installments, beginning with the taxable year in which the property is placed in service. The credit may not exceed $2,500,000 per installation (the maximum credit amount is less for residential property). The portion allowed to each taxpayer is equal to the percentage of the total costs for which the nonprofit organization would have been eligible for a credit which were covered by the taxpayer's eligible contribution.

The tax credit may be taken against either the franchise tax or the individual or corporate income tax. The election is binding and any carry forwards of a credit must be claimed against the same tax. The credit may not exceed 50% of the tax against which it is claimed. Any unused portion of the credit may be carried forward for five years. The credit is effective for taxable years beginning on or after January 1, 2007. Although this credit does not have a sunset, the credit under G.S. 105-129.16A expires for renewable energy property placed into service on or after January 1, 2011.

There is no data on the number of taxpayers that might donate to nonprofits for renewable energy purposes. Likewise, the total dollars donated cannot be estimated.

SOURCES OF DATA: NC Utilities Commission; NC Department of Revenue; State Energy Office; U.S. Department of Energy; Moody's economy.com

TECHNICAL CONSIDERATIONS: Section 14 does not make clear how the portion allowed each taxpayer is to be calculated.

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APPROVED BY: Lynn Muchmore, Director
Fiscal Research Division



DATE: July 28, 2007

Signed Copy Located in the NCGA Principal Clerk's Offices

SENATE BILL 3:
Promote Renewable Energy/Energy Efficiency

BILL ANALYSIS

Committee:		**Date:**	August 20, 2007
Introduced by:	Sen. Albertson	**Summary by:**	Jeff Hudson,
Version:	S.L. 2007-397		Staff Attorney

SUMMARY:

Senate Bill 3 would:

Establish a Renewable Energy and Energy Efficiency Portfolio Standard (REPS) in North Carolina that would include:

- ***A 12.5% REPS for electric public utilities.***
- ***A 10% REPS for electric membership corporations and municipalities that sell electric power in the State.***
- ***Provisions to encourage the use of solar energy, swine waste, and poultry waste resources.***
- ***Provisions to encourage the implementation of demand-side management and energy efficiency programs.***

Amend the cost recovery procedures for electric power suppliers to provide for:

- ***Recovery of additional costs under the annual fuel charge.***
- ***Ongoing review of construction costs and the inclusion of construction costs in rates.***
- ***Recovery of construction costs for out-of-state electric generating facilities.***
- ***Recovery of project development costs for nuclear facilities.***
- ***Expanded recovery of construction work in progress under certain circumstances.***

Adjust the public utility and electric membership corporation regulatory fees.

Phase out the sales taxes paid by farmers and manufacturers for electricity, piped natural gas, and other fuels.

Establish renewable energy tax credits.

BILL ANALYSIS:

ESTABLISH RENEWABLE ENERGY AND ENERGY EFFICIENCY PORTFOLIO STANDARD.

Renewable Energy Portfolio Standards (REPS) require that utilities operating within a state provide a designated amount or percentage of power from renewable energy resources as a portion of their overall provision of electricity. Iowa enacted the first REPS in 1991 and as of June 2007, REPS have been enacted by the majority of the 24 states and the District of Columbia that have adopted standards requiring electric utilities to generate electricity from renewable resources. Over half of the American public lives in a state in which a REPS is in effect. The map at the end of this analysis identifies those states that have adopted standards for renewable energy generation.

States have adopted or expanded their REPS for many reasons including: economic development benefits through the promotion of a state's renewable energy resources; potential for jobs creation; prospect of increased reliability in electricity supply; and reduction of conventional air pollutants and greenhouse gases.

(From: *Race to the Top: The Expanding Role of U.S. State Renewable Portfolio Standards*, http://www.pewclimate.org/docUploads/RPSReportFinal%2Epdf.)

Section 1 would provide that it is the policy of the State to promote the development of renewable energy and energy efficiency through the implementation of a Renewable Energy and Energy Efficiency Portfolio Standard (REPS) that will:

- Diversify the resources used to reliably meet the energy needs of consumers in the State.
- Provide greater energy security through the use of indigenous energy resources available within the State.
- Encourage private investment in renewable energy and energy efficiency.
- Provide improved air quality and other benefits to energy consumers and citizens of the State.

Section 2 defines "renewable energy resource" as a solar electric, solar thermal, wind, hydropower, geothermal, or ocean current or wave energy resource; a biomass resource, including agricultural waste, animal waste, wood waste, spent pulping liquors, combustible residues, combustible liquids, combustible gases, energy crops, or landfill methane; waste heat derived from a renewable energy resource and used to produce electricity or useful, measurable thermal energy at a retail electric customer's facility; or hydrogen derived from a renewable energy resource. "Renewable energy resource" does not include peat, a fossil fuel or nuclear energy resource.

Section 2 would establish a Renewable Energy and Energy Efficiency Portfolio Standard (REPS) in North Carolina as follows:

Electric Public Utilities

Each electric public utility in the State would have to meet the Renewable Energy and Energy Efficiency Portfolio Standard (REPS) according to the following schedule:

Calendar Year	REPS Requirement
2012	3% of 2011 North Carolina retail sales
2015	6% of 2014 North Carolina retail sales
2018	10% of 2017 North Carolina retail sales
2021 and thereafter	12.5% of 2020 North Carolina retail sales

An electric public utility could meet the REPS requirement by doing any one or more of the following:

- Generate electric power at a new renewable energy facility.
- Use a renewable energy resource to generate electric power at a generating facility.
- Reduce energy consumption through the implementation of an energy efficiency measure.
- Purchase electric power from a new renewable energy facility.
- Purchase renewable energy certificates derived from in-state or out-of-state new renewable energy facilities.
- Use electric power that is supplied by a new renewable energy facility or saved due to the implementation of an energy efficiency measure that exceeds the requirements of this section for any calendar year as a credit towards meeting the requirements of this section in the following calendar year or sell the associated renewable energy certificates.

Electric Membership Corporations and Municipalities

Each electric membership corporation and municipality that sells electric power to retail electric customers in the State would have to meet the Renewable Energy and Energy Efficiency Portfolio Standard (REPS) according to the following schedule:

Calendar Year	REPS Requirement
2012	3% of 2011 North Carolina retail sales
2015	6% of 2014 North Carolina retail sales
2018 and thereafter	10% of 2017 North Carolina retail sales

An electric membership corporation or municipality could meet the REPS requirement by doing any one or more of the following:

- Generate electric power at a new renewable energy facility.
- Reduce energy consumption through the implementation of an energy efficiency measure.
- Purchase electric power from a new renewable energy facility.
- Purchase renewable energy certificates derived from in-state or out-of-state new renewable energy facilities.
- Acquire all or part of its electric power from an electric power supplier who meets the requirements of this section.
- Use electric power that is supplied by a new renewable energy facility or saved due to the implementation of an energy efficiency measure that exceeds the requirements of this section for any calendar year as a credit towards meeting the requirements of this section in the following calendar year or sell the associated renewable energy certificates.

Use of Solar Energy Resources

For calendar year 2018 and each calendar year thereafter, at least two tenths of one percent (0.2%) of the total electric power in kilowatt-hours sold to retail electric customers in the State would have to be supplied by a combination of new solar electric facilities and new metered solar thermal energy facilities

that use solar hot water, solar absorption cooling, solar dehumidification, solar thermally driven refrigeration, or solar industrial process heat. Electric power suppliers would comply with these requirements according to the following schedule:

Calendar Year	Requirement for Solar Energy Resources
2010	0.02%
2012	0.07%
2015	0.14%
2018	0.20%

Use of Swine Waste Resources

For calendar year 2018 and each calendar year thereafter, at least two tenths of one percent (0.2%) of the total electric power in kilowatt-hours sold to retail electric customers in the State would have to be supplied by swine waste. Electric power suppliers would comply with these requirements according to the following schedule:

Calendar Year	Requirement for Swine Waste Resources
2012	0.07%
2015	0.14%
2018	0.20%

Use of Poultry Waste Resources

For calendar year 2014 and each calendar year thereafter, at least nine hundred thousand (900,000) megawatt-hours of the total electric power sold to retail electric customers in the State would have to be supplied by poultry waste. Electric power suppliers would comply with these requirements according to the following schedule:

Calendar Year	Requirement for Poultry Waste Resources
2012	170,000 megawatt-hours
2013	700,000 megawatt-hours
2014	900,000 megawatt-hours

Control of Emissions

A biomass combustion process at any new renewable energy facility that delivers electric power to an electric power supplier would have to reduce emissions of air pollutants to the degree that is achievable for the facility, taking into account energy, environmental, and economic impacts and other costs.

Cost Cap

The recovery of costs that would be incurred by an electric power supplier to comply with the REPS requirements could not exceed an amount equal to the per-customer annual charges in the following schedule:

Customer Class	2008-2011	2012-2014	2015 and thereafter
Residential per account	$10.00	$12.00	$34.00
Commercial per account	$50.00	$150.00	$150.00
Industrial per account	$500.00	$1,000.00	$1,000.00

Adoption of Rules by the Utilities Commission

The Utilities Commission (Commission) would adopt rules to implement the REPS requirements that specifically:

- Provide for the monitoring of compliance with and enforcement of the REPS requirements.
- Include a procedure to modify or delay the REPS requirements in whole or in part if the Commission determines that it is in the public interest to do so and the public utility demonstrates that it has made a reasonable effort to meet the REPS requirements.
- Ensure that energy credited toward compliance with the provisions of this section not be credited toward any other purpose.
- Establish standards for interconnection of renewable energy facilities and other non-utility owned generation with a generation capacity of 10 megawatts or less to a public utility's electric distribution system.
- Ensure that the owner and operator of each renewable energy facility that delivers electric power to an electric power supplier is in substantial compliance with all federal and state laws, regulations, and rules for the protection of the environment and conservation of natural resources.
- Consider whether it is in the public interest to adopt rules for electric public utilities for net metering of renewable energy facilities with a generation capacity of one megawatt or less.
- Track and account for renewable energy certificates.

Reports, Evaluation, and Analysis

No later than October 1 of each year, beginning October 1, 2008, the Commission would submit a report on the activities taken by the Commission to implement and by electric power suppliers to comply with the REPS requirements to the Governor, the Environmental Review Commission, and the Joint Legislative Utility Review Committee.

The Commission would establish a procedure for evaluating renewable energy technologies; standards to ensure that renewable energy technologies do not harm the environment, natural resources, cultural resources, or public health, safety, or welfare of the State; and a permitting program to implement these protective standards.

No later than September 1 2008, the Commission would prepare and submit an analysis of whether rate structures, policies, and measures, including decoupling, in place in other states and countries that promote a mix of generation involving renewable energy sources and demand reduction should be implemented in North Carolina to the Governor, the Environmental Review Commission, and the Joint Legislative Utility Review Committee.

No later than October 1 of odd-numbered years, beginning October 1, 2009, the Commission would submit to the Governor, the Environmental Review Commission, and the Joint Legislative Utility Review Committee a report on the actual results of the costs allocation established by the act.

Section 3 would provide that if the federal government imposes requirements similar to the REPS requirements on electric power suppliers in the State, the Commission will determine the applicability of federal and State requirements so as to apply the more stringent requirements. The Commission would adopt rules to establish a procedure as an alternative to the procedure set out in G.S. 62-133 to annually adjust the rates of electric public utilities to allow timely recovery of all reasonable costs of compliance with the federal and State requirements. In adopting rules to establish the procedure, the Commission would incorporate the provisions of this act in accordance with this section and the public interest.

DEMAND-SIDE MANAGEMENT AND ENERGY EFFICIENCY MEASURES.

Section 2 defines "Demand-side management" as activities, programs, or initiatives undertaken by an electric power supplier or its customers to shift the timing of electricity use from peak to non peak demand periods. 'Demand side management' includes, but is not limited to, load management, electric system equipment and operating controls, direct load control, and interruptible load. This section defines "energy efficiency measure" as an equipment, physical, or program change implemented after 1 January 2007 that results in less energy used to perform the same function. 'Energy efficiency measure' includes, but is not limited to, energy produced from a combined heat and power system that uses non-renewable energy resources. 'Energy efficiency measure' does not include demand side management.

Section 4 would direct electric power suppliers to implement demand-side management and energy efficiency measures to establish the least cost mix of demand reduction and generation measures that meet the electricity needs of its customers. An electric power supplier may petition the Commission to approve an annual rider to its rates to recover all reasonable and prudent costs incurred for adoption and implementation of demand-side management and energy efficiency measures adopted and implemented after 1 January 2007. The Commission would assign the costs of measures only to the class of customers that directly benefit from the measures. No costs of demand-side management or energy efficiency programs would be assigned to an industrial customer that has or will implement its own demand-side management and energy efficiency measures. Recoverable costs would include, but not be limited to, all capital costs, including cost of capital and depreciation expenses, administrative costs, implementation costs, incentive payments to program participants, and operating costs.

AMEND COST RECOVERY PROCEDURES FOR ELECTRIC POWER SUPPLIERS.

Section 5: Recovery of Additional Costs under the Annual Fuel Charge.

Section 5 would shift the recovery of certain costs incurred by an electric public utility from recovery through the rate base to recovery through the annual fuel charge adjustment. The new costs that would be recoverable under this provision would be:

- The cost of ammonia, lime, limestone, urea, dibasic acid, sorbents, and catalysts consumed in reducing or treating emissions. These costs would be adjusted for gains or losses resulting from the sale of byproducts produced in the generation process.
- The total delivered non-capacity related costs, including all related transmission charges, of all purchases of electric power by the electric public utility.
- The capacity costs associated with purchases of electric power from qualifying cogeneration facilities and qualifying small power production facilities.
- Except for those costs recovered pursuant to the new REPS requirement statute, the total delivered costs of purchases of power from renewable energy facilities and new renewable energy facilities pursuant to the REPS requirement or any similar federal requirement.

- Cost recoverable under the fuel charge would be adjusted for gains or losses resulting from the sale of fuel, and other fuel related costs components.

For he total delivered non-capacity costs, the capacity costs associated with purchasing electric power from qualifying cogeneration and qualifying small power production facilities, and the costs of purchases of power from renewable energy facilities and new renewable energy facilities, the annual increase in the aggregate amount of these costs that are recoverable by an electric public utility could not exceed two percent (2%) of the electric public utility's total North Carolina retail jurisdictional gross revenues for the preceding calendar year. These costs would be recoverable from each class of customers as a separate component of the rider as follows:

- For the total delivered non-capacity costs, the specific component for each class of customers would be determined by allocating these costs among customer classes based on the electric public utility's North Carolina energy usage for the prior year, as determined by the Commission, until the Commission determines how these costs should be allocated in a general rate case for the electric public utility commenced on or after 1 January 2008.
- For the capacity costs associated with purchasing electric power from qualifying cogeneration and qualifying small power production facilities and the costs of purchases of power from renewable energy facilities and new renewable energy facilities, the specific component for each class of customers would be determined by allocating these costs among customer classes based on the electric public utility's North Carolina peak demand for the prior year, as determined by the Commission, until the Commission determines how these costs should be allocated in a general rate case for the electric public utility commenced on or after 1 January 2008.

Notwithstanding these provisions, cost recovery under the fuel charge would be modified for an electric public utility that has less than 150,000 North Carolina retail jurisdictional customers as of December 31, 2006.

Section 6: Ongoing Review of Construction Costs and Inclusion of Construction Costs in Rates.

Under current law, an electric public utility is responsible for bearing the construction costs of a generating facility until the facility goes into operation. In the first general rate case after the facility goes into service, if the Commission finds the facility to be used and useful, the total facility costs, excluding any imprudently incurred costs, are included in rates charged to customers. There is one exception to this system of construction cost recovery; prudently incurred expenses for construction work in progress may be included in the rate base if the Commission finds that this is in the public interest and is necessary to the utility's financial stability.

Under current practice, if a facility is abandoned before it is completed, the Commission may authorize the electric public utility to recover the costs of the incomplete facility, excluding any imprudently incurred costs, by amortizing these costs over a period of years, with no return on the unamortized balance.

Section 6 would alter these current procedures for construction cost recovery as follows.

A certificate for the construction of a coal or nuclear facility would be granted only if the applicant demonstrated and the Commission found that energy efficiency measures, demand side management, renewable energy resource generation, combined heat and power generation, or any combination of these, would not create a more cost effective and reliable generation system and that the construction and operation of such a facility is in the public interest.

Once a construction certificate has been granted by the Commission, a public utility may not cancel construction of a generating facility without receiving approval from the Commission. If the Commission finds that completion of the generating facility is no longer in the public interest, the Commission may modify or revoke the certificate.

A public utility would submit an annual progress report on construction to the Commission, including any revisions in the cost estimate for the construction. The Commission may conduct an ongoing review of construction of the facility. If the Commission disapproves any part of the revised cost estimate or finds that the incurrence of the cost of that portion of the construction of the facility then under review was unreasonable or imprudent, the Commission may modify or revoke the certificate.

The public utility would recover through rates in a general rate case the actual costs it has incurred in constructing a generating facility in reliance on a construction certificate as provided below, unless new evidence is discovered (i) that could not have been discovered by due diligence at an earlier time and (ii) that reasonably tends to show that a previous determination by the Commission that a material item of cost had been just and reasonable and prudently incurred was erroneous. The public utility would have the burden of proof to demonstrate that the material item of cost was in fact just and reasonable and prudently incurred.

Whether under construction or completed, if the construction of the facility:

- Has been subject to ongoing review, the reasonable and prudent costs of construction approved by the Commission during the ongoing review would be included in the public utility's rate base.
- Has not been subject to ongoing review, the costs of construction would be included in the public utility's rate base if the Commission finds that the incurrence of these costs is reasonable and prudent.

If the construction of a facility is cancelled and the facility:

- Has been subject to ongoing review, the public utility would recover through rates in a general rate case the costs of construction approved by the Commission during the ongoing review that were actually incurred prior to cancellation, amortized over a reasonable time as determined by the Commission. The public utility would have the burden of proof to demonstrate that the material item of cost was in fact just and reasonable and prudently incurred. In the general rate case, the Commission would make any adjustment that may be required.
- Has not been subject to ongoing review, the public utility would recover through rates in a general rate case the costs of construction that were actually incurred prior to cancellation and are found by the Commission to be reasonable and prudent, amortized over a reasonable time as determined by the Commission. In the general rate case, the Commission would make any adjustment that may be required.

Section 7: Recovery of Construction Costs for Out-of-State Electric Generating Facilities and Project Development Costs for Nuclear Facilities.

Section 7 would provide that upon petition by a public utility, the Commission would determine the need for and, if need is established, approve an estimate of the construction costs and construction schedule for an electric generating facility in another state. The construction cost estimate and the recovery of costs through a general rate case would be governed by the provision that apply to facilities built in the State (see Section 6 above).

Sections 7 would also provide for the treatment of project development costs for a nuclear facility as follows:

Section 7 defines "project development costs" as all capital costs associated with a potential nuclear electric generating facility, including the costs of evaluation, design, engineering, environmental analysis and permitting, early site permitting, combined operating license permitting, initial site preparation costs, and allowance for funds used during construction associated with such costs.

A public utility would be able to request that the Commission review the public utility's decision to incur project development costs for the construction of a nuclear electric generating facility. The Commission would approve the public utility's decision to incur project development costs if the public utility demonstrates by a preponderance of evidence that the decision to incur project development costs is reasonable and prudent.

All reasonable and prudent project development costs, as determined by the Commission, incurred for the potential nuclear electric generating facility would be included in the public utility's rate base and would be fully recoverable through rates in a general rate case If the public utility is allowed to cancel the project, the Commission would permit the public utility to recover all reasonable and prudently incurred project development costs in a general rate case amortized over a period equal to the period during which the costs were incurred, or five years, whichever is greater.

Section 8: Recovery of Construction Work in Progress.

Section 8 would change the standard by which the Commission may include construction work in progress included in rates. Under current law, construction work in progress may only be included if the Commission determines that inclusion is in the public interest and necessary to the financial stability of the utility. Section 8 would allow inclusion of construction work in progress if the construction is subject to ongoing review and Commission determines that expenditures are reasonable and prudent.

ADJUST THE PUBLIC UTILITY AND ELECTRIC MEMBERSHIP CORPORATION REGULATORY FEES.

Section 9 would provide that the percentage rate to be used in calculating the public utility regulatory fee under G.S. 62-302(b)(2) is twelve one-hundredths of one percent (0.12%) for each public utility's North Carolina jurisdictional revenues earned during each quarter that begins on or after July 1, 2007. This section also provides that the electric membership corporation regulatory fee imposed under G.S. 62-302(b1) for the 2007-2008 fiscal year is two hundred thousand dollars ($200,000).

PHASE OUT OF SALES TAXES PAID BY FARMERS AND MANUFACTURERS ON ELECTRICITY, PIPED NATURAL GAS, AND OTHER FUELS.

Sections 10, 11, and 12 would phase out the tax on electricity, piped natural gas, and fuel used by manufacturers to operate their industries and by farmers in their farming operations, effective for sales made on or after July 1, 2007

Section 10 would phase out the current sales tax rate of 2.83% on sales of electricity to manufacturing industries and manufacturing plants for use in connection with their operation and to farmers to be used by them for farming purposes as follows:

- Effective October 1, 2007, reduces the rate from 2.83% to 1.8%.
- Effective July 1, 2008, reduces the rate from 1.8% to 1.4%.
- Effective July 1, 2009, reduces the rate from 1.4% to 0.8%.

- Effective July 1, 2010, exempts these sales from tax.

The general rate of tax on sales of electricity is 3%. Sales of electricity to an aluminum smelting facility are taxed at the rate of 1%, but this rate expires for sales made on or after October 1, 2007. Last session, in S.L. 2006-66, the tax on sales of electricity to manufacturing industries and manufacturing plants was reduced from 2.83% to 2.6%, effective July 1, 2007. This bill repeals the reduction enacted last session and replaces it with the 1.89% rate provided in this section of the bill.

Section 11 would phase out the tax imposed on piped natural gas received by a manufacturer for use in connection with the operation of the manufacturing facility and on piped natural gas received by a farmer to be used for any farming purpose, other than preparing food, heating dwellings, and other household purposes.

The excise tax on piped natural gas applies uniformly to all users. The tax rate is structured as a "declining block" that decreases as the amount of therms of piped gas consumed in a month increases. A declining block tax rate structure means that low end users, such as residential users, pay a higher effective rate of tax and high volume users, such as business and industrial users, pay a lower effective rate of tax.

Section 12 would phase out the privilege tax imposed on a manufacturing industry or plant that purchases fuel to operate the industry or plant by reducing the tax rate from 1% to 0.7%, effective October 1, 2007, from 0.7% to 0.5%, effective July 1, 2008, from 0.5% to 0.3%, effective July 1, 2009, and from 0.3% to 0%, effective July 1, 2010.

Farmers are exempt from sales tax on purchases of fuel. Manufacturers are exempt from sales tax on fuel, but they are subject to a privilege tax equal to 1% of the sales price of the fuel. This section would phase that tax out over four years.

ESTABLISH RENEWABLE ENERGY TAX CREDITS.

Section 13

G.S. 105-129.16A provides a tax credit for investing in renewable energy property. This tax credit is not used by a nonprofit corporation that invests in renewable energy property because the nonprofit organization does not owe any tax. Section 13 would allow this tax credit to a taxpayer that makes an eligible contribution to a nonprofit organization organized under section 501(c)(3) of the Code. An eligible contribution is a contribution designated by the taxpayer to be used for investing in renewable energy property and used by the nonprofit organization for investing in renewable energy property.

The amount of the credit would be equal to a portion of the credit for investing in renewable energy property that the nonprofit organization would be allowed if the nonprofit organization was subject to tax. The amount of the credit for investing in renewable energy property is 35% of the cost of the property placed in service. The portion allowed to each taxpayer is equal to the percentage of the total costs for which the nonprofit organization would have been eligible for a credit which were covered by the taxpayer's eligible contribution.

The tax credit may be taken against either the franchise tax or the individual or corporate income tax. The election is binding and any carryforwards of a credit must be claimed against the same tax. The credit may not exceed 50% of the tax against which it is claimed. The credit is effective for taxable years beginning on or after January 1, 2007. Although this credit does not have a sunset, the credit under G.S. 105-129.16A expires for renewable energy property placed into service on or after January 1, 2011.

Renewable energy property includes the following machinery and equipment or real property:

- Biomass equipment that uses renewable biomass resources for biofuel production of ethanol, methanol, and biodiesel; anaerobic biogas production of methane utilizing agricultural and animal waste or garbage; or commercial thermal or electrical generation from renewable energy crops or wood waste materials. Renewable biomass resources are organic matters produced by terrestrial and aquatic plants and animals, such as standing vegetation, forestry and agricultural residues, landfill wastes, and animal wastes.
- Hydroelectric generators
- Solar energy equipment
- Wind equipment

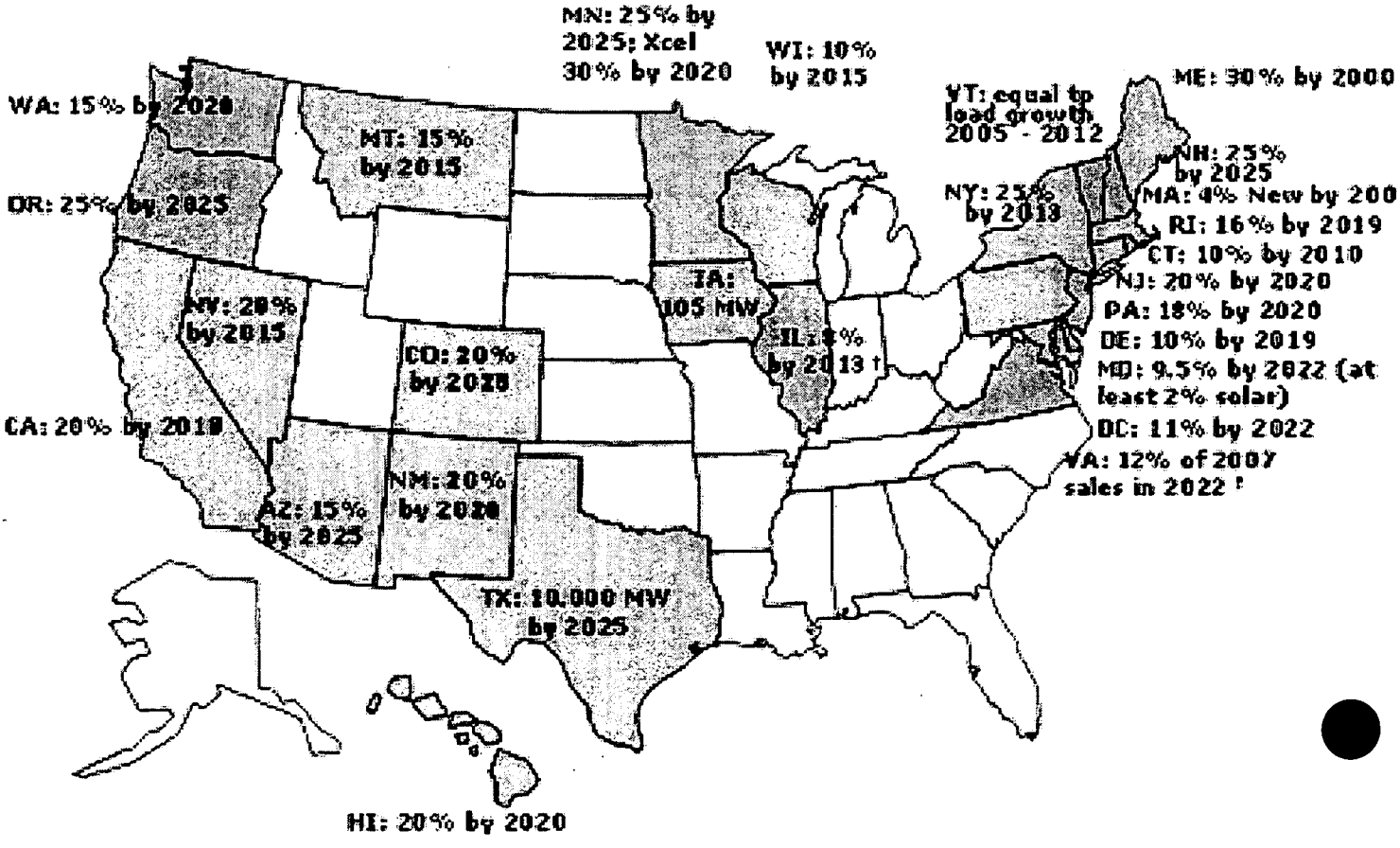
SEVERABILITY CLAUSE AND EFFECTIVE DATES.

Section 15 would provide that if any section or provision of the act is declared unconstitutional or invalid by the courts, the unconstitutional or invalid section or provision does not affect the validity of the act as a whole or any part of the act other than the unconstitutional or invalid part.

Section 16 would provide for the effective dates of the act as follows:

- Sections 1, 2, 6, 7, and 8 of the act would become effective 1 January 2008. The provisions of Section 2 of the act that provide for the recovery of costs incurred under Section 2 apply only to costs that are incurred on and after 1 January 2008.
- Sections 3, 4, 15, and 16 of the act would become effective when the act becomes law. The provisions of Section 4 of the act that provide for the recovery of costs incurred under Section 4 apply only to costs that are incurred on and after the date that the act becomes law.
- Section 5 of the act would become effective 1 January 2008 provided that (i) the provisions of G.S. 62-133.2, as amended by Section 5 of the act, apply only to fuel and fuel related costs incurred on and after 1 January 2008 regardless of the test period established by the Utilities Commission, and (ii) the costs described in G.S. 62-133.2(a1)(3) that are incurred on and after the date the act becomes law will be recoverable as provided in G.S. 62-133.2, as amended by Section 5 of the act.
- Sections 10, 11, 12, 13, and 14 of the act would become effective as provided in those sections.
- Section 9 of the act would become effective 1 July 2007.

States with Renewable Energy Portfolio Standards as of June 2007



†IL and VA RPS implemented through voluntary utility commitments

The percentages shown on the map for each state are not directly comparable to one another because each states' standard varies in its regulatory design with respect to: the definition of qualifying renewable energy resources; provisions for energy efficiency measures and applicability of renewable energy credit trading mechanisms; mandatory versus voluntary commitments; compliance standards and timetables; and the predominant state goals underlying development and implementation of the standard.

(From: The Pew Center on Global Climate Change, http://www.pewclimate.org/what_s_being_done/in_the_states/rps.cfm)

Cindy Avrette, Committee Counsel, Finance Committees; Jennifer Mundt, Legislative Analyst for the Senate Committee on Agriculture, Environment, and Natural Resources; and Diana Jessup, Staff Attorney, North Carolina Utilities Commission - Public Staff, contributed to this summary.

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GENERAL ASSEMBLY OF NORTH CAROLINA
SESSION 2007

SESSION LAW 2007-397
SENATE BILL 3

AN ACT TO: (1) PROMOTE THE DEVELOPMENT OF RENEWABLE ENERGY AND ENERGY EFFICIENCY IN THE STATE THROUGH IMPLEMENTATION OF A RENEWABLE ENERGY AND ENERGY EFFICIENCY PORTFOLIO STANDARD (REPS), (2) ALLOW RECOVERY OF CERTAIN NONFUEL UTILITY COSTS THROUGH THE FUEL CHARGE ADJUSTMENT PROCEDURE, (3) PROVIDE FOR ONGOING REVIEW OF CONSTRUCTION COSTS AND FOR RECOVERY OF COSTS IN RATES IN A GENERAL RATE CASE, (4) ADJUST THE PUBLIC UTILITY AND ELECTRIC MEMBERSHIP CORPORATION REGULATORY FEES, (5) PROVIDE FOR THE PHASEOUT OF THE TAX ON THE SALE OF ENERGY TO NORTH CAROLINA FARMERS AND MANUFACTURERS, AND (6) ALLOW A TAX CREDIT TO CONTRIBUTORS TO 501(C)(3) ORGANIZATIONS FOR RENEWABLE ENERGY PROPERTY.

The General Assembly of North Carolina enacts:

SECTION 1. G.S. 62-2(a) reads as rewritten:

"**§ 62-2. Declaration of policy.**

(a) Upon investigation, it has been determined that the rates, services and operations of public utilities as defined herein, are affected with the public interest and that the availability of an adequate and reliable supply of electric power and natural gas to the people, economy and government of North Carolina is a matter of public policy. It is hereby declared to be the policy of the State of North Carolina:

...

(8) To cooperate with other states and with the federal government in promoting and coordinating interstate and intrastate public utility service and reliability of public utility energy supply; ~~and~~

(9) To facilitate the construction of facilities in and the extension of natural gas service to unserved areas in order to promote the public welfare throughout the State and to that end to authorize the creation of expansion funds for natural gas local distribution companies or gas districts to be administered under the supervision of the North Carolina Utilities ~~Commission.~~Commission; and

(10) To promote the development of renewable energy and energy efficiency through the implementation of a Renewable Energy and Energy Efficiency Portfolio Standard (REPS) that will do all of the following:

a. Diversify the resources used to reliably meet the energy needs of consumers in the State.

b. Provide greater energy security through the use of indigenous energy resources available within the State.

c. Encourage private investment in renewable energy and energy efficiency.

d. Provide improved air quality and other benefits to energy consumers and citizens of the State."

SECTION 2.(a) Article 7 of Chapter 62 of the General Statutes is amended by adding a new section to read:

"**§ 62-133.7. Renewable Energy and Energy Efficiency Portfolio Standard (REPS).**

(a) Definitions. – As used in this section:

(1) 'Combined heat and power system' means a system that uses waste heat to produce electricity or useful, measurable thermal or mechanical energy at a retail electric customer's facility.

(2) 'Demand-side management' means activities, programs, or initiatives undertaken by an electric power supplier or its customers to shift the timing of electricity use from peak to nonpeak demand periods. 'Demand-side management' includes, but is not limited to, load management, electric system equipment and operating controls, direct load control, and interruptible load.

(3) 'Electric power supplier' means a public utility, an electric membership corporation, or a municipality that sells electric power to retail electric power customers in the State.

(4) 'Energy efficiency measure' means an equipment, physical, or program change implemented after 1 January 2007 that results in less energy used to perform the same function. 'Energy efficiency measure' includes, but is not limited to, energy produced from a combined heat and power system that uses nonrenewable energy resources. 'Energy efficiency measure' does not include demand-side management.

(5) 'New renewable energy facility' means a renewable energy facility that either:

a. Was placed into service on or after 1 January 2007.

b. Delivers or has delivered electric power to an electric power supplier pursuant to a contract with NC GreenPower Corporation that was entered into prior to 1 January 2007.

c. Is a hydroelectric power facility with a generation capacity of 10 megawatts or less that delivers electric power to an electric power supplier.

(6) 'Renewable energy certificate' means a tradable instrument that is equal to one megawatt hour of electricity or equivalent energy supplied by a renewable energy facility, new renewable energy facility, or reduced by implementation of an energy efficiency measure that is used to track and verify compliance with the requirements of this section as determined by the Commission. A 'renewable energy certificate' does not include the related emission reductions, including, but not limited to, reductions of sulfur dioxide, oxides of nitrogen, mercury, or carbon dioxide.

(7) 'Renewable energy facility' means a facility, other than a hydroelectric power facility with a generation capacity of more than 10 megawatts, that either:

a. Generates electric power by the use of a renewable energy resource.

b. Generates useful, measurable combined heat and power derived from a renewable energy resource.

c. Is a solar thermal energy facility.

(8) 'Renewable energy resource' means a solar electric, solar thermal, wind, hydropower, geothermal, or ocean current or wave energy resource; a biomass resource, including agricultural waste, animal waste, wood waste, spent pulping liquors, combustible residues, combustible liquids, combustible gases, energy crops, or landfill methane; waste heat derived from a renewable energy resource and used to produce electricity or useful, measurable thermal energy at a

retail electric customer's facility; or hydrogen derived from a renewable energy resource. 'Renewable energy resource' does not include peat, a fossil fuel, or nuclear energy resource.

(b) Renewable Energy and Energy Efficiency Standards (REPS) for Electric Public Utilities. –

(1) Each electric public utility in the State shall be subject to a Renewable Energy and Energy Efficiency Portfolio Standard (REPS) according to the following schedule:

Calendar Year	REPS Requirement
2012	3% of 2011 North Carolina retail sales
2015	6% of 2014 North Carolina retail sales
2018	10% of 2017 North Carolina retail sales
2021 and thereafter	12.5% of 2020 North Carolina retail sales

(2) An electric public utility may meet the requirements of this section by any one or more of the following:

a. Generate electric power at a new renewable energy facility.

b. Use a renewable energy resource to generate electric power at a generating facility other than the generation of electric power from waste heat derived from the combustion of fossil fuel.

c. Reduce energy consumption through the implementation of an energy efficiency measure; provided, however, an electric public utility subject to the provisions of this subsection may meet up to twenty-five percent (25%) of the requirements of this section through savings due to implementation of energy efficiency measures. Beginning in calendar year 2021 and each year thereafter, an electric public utility may meet up to forty percent (40%) of the requirements of this section through savings due to implementation of energy efficiency measures.

d. Purchase electric power from a new renewable energy facility. Electric power purchased from a new renewable energy facility located outside the geographic boundaries of the State shall meet the requirements of this section if the electric power is delivered to a public utility that provides electric power to retail electric customers in the State; provided, however, the electric public utility shall not sell the renewable energy certificates created pursuant to this paragraph to another electric public utility.

e. Purchase renewable energy certificates derived from in-State or out-of-state new renewable energy facilities. Certificates derived from out-of-state new renewable energy facilities shall not be used to meet more than twenty-five percent (25%) of the requirements of this section, provided that this limitation shall not apply to an electric public utility with less than 150,000 North Carolina retail jurisdictional customers as of 31 December 2006.

f. Use electric power that is supplied by a new renewable energy facility or saved due to the implementation of an energy efficiency measure that exceeds the requirements of this section for any calendar year as a credit towards the requirements of this section in the following calendar year or sell the associated renewable energy certificates.

(c) Renewable Energy and Energy Efficiency Standards (REPS) for Electric Membership Corporations and Municipalities. –

(1) Each electric membership corporation or municipality that sells electric power to retail electric power customers in the State shall be

subject to a Renewable Energy and Energy Efficiency Portfolio Standard (REPS) according to the following schedule:

Calendar Year	REPS Requirement
2012	3% of 2011 North Carolina retail sales
2015	6% of 2014 North Carolina retail sales
2018 and thereafter	10% of 2017 North Carolina retail sales

(2) An electric membership corporation or municipality may meet the requirements of this section by any one or more of the following:

a. Generate electric power at a new renewable energy facility.

b. Reduce energy consumption through the implementation of demand-side management or energy efficiency measures.

c. Purchase electric power from a renewable energy facility or a hydroelectric power facility, provided that no more than thirty percent (30%) of the requirements of this section may be met with hydroelectric power, including allocations made by the Southeastern Power Administration.

d. Purchase renewable energy certificates derived from in-State or out-of-state renewable energy facilities. An electric power supplier subject to the requirements of this subsection may use certificates derived from out-of-state renewable energy facilities to meet no more than twenty-five percent (25%) of the requirements of this section.

e. Acquire all or part of its electric power through a wholesale purchase power agreement with a wholesale supplier of electric power whose portfolio of supply and demand options meets the requirements of this section.

f. Use electric power that is supplied by a new renewable energy facility or saved due to the implementation of demand-side management or energy efficiency measures that exceeds the requirements of this section for any calendar year as a credit towards the requirements of this section in the following calendar year or sell the associated renewable energy certificates.

(d) Compliance With REPS Requirement Through Use of Solar Energy Resources. – For calendar year 2018 and for each calendar year thereafter, at least two-tenths of one percent (0.2%) of the total electric power in kilowatt hours sold to retail electric customers in the State, or an equivalent amount of energy, shall be supplied by a combination of new solar electric facilities and new metered solar thermal energy facilities that use one or more of the following applications: solar hot water, solar absorption cooling, solar dehumidification, solar thermally driven refrigeration, and solar .industrial process heat. The terms of any contract entered into between an electric power supplier and a new solar electric facility or new metered solar thermal energy facility shall be of sufficient length to stimulate development of solar energy; provided, the Commission shall develop a procedure to determine if an electric power supplier is in compliance with the provisions of this subsection if a new solar electric facility or a new metered solar thermal energy facility fails to meet the terms of its contract with the electric power supplier. As used in this subsection, 'new' means a facility that was first placed into service on or after 1 January 2007. The electric power suppliers shall comply with the requirements of this subsection according to the following schedule:

Calendar Year	Requirement for Solar Energy Resources
2010	0.02%
2012	0.07%
2015	0.14%
2018	0.20%

(e) Compliance With REPS Requirement Through Use of Swine Waste Resources. – For calendar year 2018 and for each calendar year thereafter, at least two-tenths of one percent (0.2%) of the total electric power in kilowatt hours sold to retail electric customers in the State shall be supplied, or contracted for supply in each year, by swine waste. The electric power suppliers, in the aggregate, shall comply with the requirements of this subsection according to the following schedule:

Calendar Year	Requirement for Swine Waste Resources
2012	0.07%
2015	0.14%
2018	0.20%

(f) Compliance With REPS Requirement Through Use of Poultry Waste Resources. – For calendar year 2014 and for each calendar year thereafter, at least 900,000 megawatt hours of the total electric power sold to retail electric customers in the State shall be supplied, or contracted for supply in each year, by poultry waste combined with wood shavings, straw, rice hulls, or other bedding material. The electric power suppliers, in the aggregate, shall comply with the requirements of this subsection according to the following schedule:

Calendar Year	Requirement for Poultry Waste Resources
2012	170,000 megawatt hours
2013	700,000 megawatt hours
2014	900,000 megawatt hours

(g) Control of Emissions. – As used in this subsection, Best Available Control Technology (BACT) means an emissions limitation based on the maximum degree a reduction in the emission of air pollutants that is achievable for a facility, taking into account energy, environmental, and economic impacts and other costs. A biomass combustion process at any new renewable energy facility that delivers electric power to an electric power supplier shall meet BACT. The Environmental Management Commission shall determine on a case-by-case basis the BACT for a facility that would not otherwise be required to comply with BACT pursuant to the Prevention of Significant Deterioration (PSD) emissions program. The Environmental Management Commission may adopt rules to implement this subsection. In adopting rules, the Environmental Management Commission shall take into account cumulative and secondary impacts associated with the concentration of biomass facilities in close proximity to one another. In adopting rules the Environmental Management Commission shall provide for the manner in which a facility that would not otherwise be required to comply with BACT pursuant to the PSD emissions programs shall meet the BACT requirement.

(h) Cost Recovery and Customer Charges. –

(1) For the purposes of this subsection, the term 'incremental costs' means all reasonable and prudent costs incurred by an electric power supplier to:

a. Comply with the requirements of subsections (b), (c), (d), (e), and (f) of this section that are in excess of the electric power supplier's avoided costs other than those costs recovered pursuant to G.S. 62-133.8.

b. Fund research that encourages the development of renewable energy, energy efficiency, or improved air quality, provided those costs do not exceed one million dollars ($1,000,000) per year.

c. Comply with any federal mandate that is similar to the requirements of subsections (b), (c), (d), (e), and (f) of this section that exceed the costs that the electric power supplier would have incurred under those subsections in the absence of the federal mandate.

(2) All reasonable and prudent costs incurred by an electric power supplier to comply with any federal mandate that is similar to the requirements of subsections (b), (c), (d), (e), and (f) of this section, including, but not limited to, the avoided costs associated with a federal mandate that exceeds the avoided costs that the electric power supplier would have incurred pursuant to subsections (b), (c), (d), (e), and (f) of this section in the absence of the federal mandate, shall be recovered by the electric power supplier in an annual rider charge assessed in accordance with the schedule set out in subdivision (4) of this subsection increased by the Commission on a pro rata basis to allow for full and complete recovery of all reasonable and prudent costs incurred to comply with the federal mandate.

(3) Except as provided in subdivision (2) of this subsection, the total annual incremental cost to be incurred by an electric power supplier and recovered from the electric power supplier's retail customers shall not exceed an amount equal to the per-account annual charges set out in subdivision (4) of this subsection applied to the electric power supplier's total number of customer accounts determined as of 31 December of the previous calendar year. An electric power supplier shall be conclusively deemed to be in compliance with the requirements of subsections (b), (c), (d), (e), and (f) of this section if the electric power supplier's total annual incremental costs incurred equals an amount equal to the per-account annual charges set out in subdivision (4) of this subsection applied to the electric power supplier's total number of customer accounts determined as of 31 December of the previous calendar year. The total annual incremental cost recoverable by an electric power supplier from an individual customer shall not exceed the per-account charges set out in subdivision (4) of this subsection except as these charges may be adjusted in subdivision (2) of this subsection.

(4) An electric power supplier shall be allowed to recover the incremental costs incurred to comply with the requirements of subsections (b), (c), (d), (e), and (f) of this section and fund research as provided in subdivision (1) of this subsection through an annual rider not to exceed the following per-account annual charges:

Customer Class	2008-2011	2012-2014	2015 and thereafter
Residential per account	$10.00	$12.00	$34.00
Commercial per account	$50.00	$150.00	$150.00
Industrial per account	$500.00	$1,000.00	$1,000.00

(5) The Commission shall adopt rules to establish a procedure for the annual assessment of the per-account charges set out in this subsection to an electric public utility's customers to allow for timely recovery of all reasonable and prudent costs of compliance with the requirements of subsections (b), (c), (d), (e), and (f) of this section and to fund research as provided in subdivision (1) of this subsection. The Commission shall ensure that the costs to be recovered from individual customers on a per-account basis pursuant to subdivisions (2) and (3) of this subsection are in the same proportion as the per-account annual charges for each customer class set out in subdivision (4) of this subsection.

(i) Adoption of Rules. – The Commission shall adopt rules to implement the provisions of this section. In developing rules, the Commission shall:

(1) Provide for the monitoring of compliance with and enforcement of the requirements of this section.

(2) Include a procedure to modify or delay the provisions of subsections (b), (c), (d), (e), and (f) of this section in whole or in part if the Commission determines that it is in the public interest to do so. The procedure adopted pursuant to this subdivision shall include a requirement that the electric power supplier demonstrate that it made a reasonable effort to meet the requirements set out in this section.

(3) Ensure that energy credited toward compliance with the provisions of this section not be credited toward any other purpose, including another renewable energy portfolio standard or voluntary renewable energy purchase program in this State or any other state.

(4) Establish standards for interconnection of renewable energy facilities and other nonutility-owned generation with a generation capacity of 10 megawatts or less to an electric public utility's distribution system; provided, however, that the Commission shall adopt, if appropriate, federal interconnection standards.

(5) Ensure that the owner and operator of each renewable energy facility that delivers electric power to an electric power supplier is in substantial compliance with all federal and state laws, regulations, and rules for the protection of the environment and conservation of natural resources.

(6) Consider whether it is in the public interest to adopt rules for electric public utilities for net metering of renewable energy facilities with a generation capacity of one megawatt or less.

(7) Develop procedures to track and account for renewable energy certificates, including ownership of renewable energy certificates that are derived from a customer owned renewable energy facility as a result of any action by a customer of an electric power supplier that is independent of a program sponsored by the electric power supplier.

(j) Report. – No later than 1 October of each year, the Commission shall submit a report on the activities taken by the Commission to implement, and by electric power suppliers to comply with, the requirements of this section to the Governor, the Environmental Review Commission, and the Joint Legislative Utility Review Committee. The report shall include any public comments received regarding direct, secondary, and cumulative environmental impacts of the implementation of the requirements of this section. In developing the report, the Commission shall consult with the Department of Environment and Natural Resources."

SECTION 2.(b) The Commission shall submit the first report required by G.S. 62-133.7(j), as enacted by subsection (a) of this section, no later than 1 October 2008.

SECTION 2.(c) G.S. 143B-282(a) reads as rewritten:

"(a) There is hereby created the Environmental Management Commission of the Department of Environment and Natural Resources with the power and duty to promulgate rules to be followed in the protection, preservation, and enhancement of the water and air resources of the State.

...

(6) The Commission may establish a procedure for evaluating renewable energy technologies that are, or are proposed to be, employed as part of a renewable energy facility, as defined in G.S. 62-133.7; establish standards to ensure that renewable energy technologies do not harm the environment, natural resources, cultural resources, or public health, safety, or welfare of the State; and, to the extent that there is not an environmental regulatory program, establish an environmental regulatory program to implement these protective standards."

SECTION 3. If the federal government imposes requirements similar to those set out in G.S. 62-133.7 on electric power suppliers in the State, the Utilities Commission shall determine the applicability of federal and State requirements so as to apply the more stringent requirements except to the extent that State requirements may be specifically preempted by federal law. The Commission shall adopt rules to establish a procedure as an alternative to the procedure set out in G.S. 62-133 to annually adjust the rates of electric public utilities to allow timely recovery of all reasonable costs of compliance with the federal and State requirements pursuant to G.S. 62-133.7(h), as enacted by Section 2 of this act. In adopting rules to establish the procedure, the Commission shall incorporate the provisions of this act in accordance with this section and the public interest.

SECTION 4.(a) Article 7 of Chapter 62 of the General Statutes is amended by adding a new section to read:

"**§ 62-133.8. Cost recovery for demand-side management and energy efficiency measures.**

(a) The definitions set out in G.S. 62-133.7 apply to this section. As used in this section, 'new,' used in connection with demand-side management or energy efficiency measure, means a demand-side management or energy efficiency measure that is adopted and implemented on or after 1 January 2007, including subsequent changes and modifications.

(b) Each electric power supplier shall implement demand-side management and energy efficiency measures and use supply-side resources to establish the least cost mix of demand reduction and generation measures that meet the electricity needs of its customers. An electric membership corporation or municipality that qualifies as an electric power supplier may satisfy the requirements of this section through its purchases from a wholesale supplier of electric power that uses supply-side resources and demand-side management to meet all or a portion of the supply needs of its members and their retail customers, and that, by aggregating and promoting demand-side management and energy efficiency measures for its members, meets the requirements of this section.

(c) Each electric power supplier to which G.S. 62-110.1 applies shall include an assessment of demand-side management and energy efficiency in its resource plans submitted to the Commission and shall submit cost-effective demand-side management and energy efficiency options that require incentives to the Commission for approval.

(d) The Commission shall, upon petition of an electric public utility, approve an annual rider to the electric public utility's rates to recover all reasonable and prudent costs incurred for adoption and implementation of new demand-side management and new energy efficiency measures. Recoverable costs include, but are not limited to, all capital costs, including cost of capital and depreciation expenses, administrative costs, implementation costs, incentive payments to program participants, and operating costs. In determining the amount of any rider, the Commission:

(1) Shall allow electric public utilities to capitalize all or a portion of those costs to the extent that those costs are intended to produce future benefits.

(2) May approve other incentives to electric public utilities for adopting and implementing new demand-side management and energy efficiency measures. Allowable incentives may include:

a. Appropriate rewards based on the sharing of savings achieved by the demand-side management and energy efficiency measures.

b. Appropriate rewards based on capitalization of a percentage of avoided costs achieved by demand-side management and energy efficiency measures.

c. Any other incentives that the Commission determines to be appropriate.

(e) The Commission shall determine the appropriate assignment of costs of new demand-side management and energy efficiency measures for electric public utilities and shall assign the costs of the programs only to the class or classes of customers that directly benefit from the programs.

(f) None of the costs of new demand-side management or energy efficiency measures of an electric power supplier shall be assigned to any industrial customer that notifies the industrial customer's electric power supplier that, at the industrial customer's own expense, the industrial customer has implemented at any time in the past or, in accordance with stated, quantified goals for demand-side management and energy efficiency, will implement alternative demand-side management and energy efficiency measures and that the industrial customer elects not to participate in demand-side management or energy efficiency measures under this section. The electric power supplier that provides electric service to the industrial customer, an industrial customer that receives electric service from the electric power supplier, the Public Staff, or the Commission on its own motion, may initiate a complaint proceeding before the Commission to challenge the validity of the notification of nonparticipation. The procedures set forth in G.S. 62-73, 62-74, and 62-75 shall govern any such complaint. The provisions of this subsection shall also apply to commercial customers with significant annual usage at a threshold level to be established by the Commission.

(g) An electric public utility shall not charge an industrial or commercial customer for the costs of installing demand-side management equipment on the customer's premises if the customer provides, at the customer's expense, equivalent demand-side management equipment.

(h) The Commission shall adopt rules to implement this section.

(i) The Commission shall submit to the Governor and to the Joint Legislative Utility Review Committee a summary of the proceedings conducted pursuant to this section during the preceding two fiscal years on or before 1 September of odd-numbered years."

SECTION 4.(b) The Utilities Commission shall submit the first report required by G.S. 62-133.8(i), as enacted by subsection (a) of this section, no later than 1 September 2009.

SECTION 4.(c) The Utilities Commission shall prepare an analysis of whether rate structures, policies, and measures, including decoupling, in place in other states and countries that promote a mix of generation involving renewable energy sources and demand reduction should be implemented in this State. The Commission shall submit this analysis to the Governor, Environmental Review Commission, and the Joint Legislative Utility Review Committee no later than 1 September 2008.

SECTION 5. G.S. 62-133.2 reads as rewritten:

"**§ 62-133.2. Fuel and fuel-related charge adjustments for electric utilities.**

(a) The Commission ~~may allow~~shall permit an electric ~~utilities~~ public utility that generates electric power by fossil fuel or nuclear fuel to charge ~~a uniform~~an increment or decrement as a rider to ~~their~~ its rates for changes in the cost of fuel ~~and the fuel component of purchased power~~and fuel-related costs used in providing ~~their~~ its North Carolina customers with electricity from the cost of fuel ~~and the fuel component of purchased power established in their previous general rate case.~~and fuel-related costs established in the electric public utility's previous general rate case on the basis of cost per kilowatt hour.

(a1) As used in this section, 'cost of fuel and fuel-related costs' means all of the following:

(1) The cost of fuel burned.

(2) The cost of fuel transportation.

(3) The cost of ammonia, lime, limestone, urea, dibasic acid, sorbents, and catalysts consumed in reducing or treating emissions.

(4) The total delivered noncapacity related costs, including all related transmission charges, of all purchases of electric power by the electric

public utility, that are subject to economic dispatch or economic curtailment.

(5) The capacity costs associated with all purchases of electric power from qualifying cogeneration facilities and qualifying small power production facilities, as defined in 16 U.S.C. § 796, that are subject to economic dispatch by the electric public utility.

(6) Except for those costs recovered pursuant to G.S. 62-133.7(h), the total delivered costs of all purchases of power from renewable energy facilities and new renewable energy facilities pursuant to G.S. 62-133.7 or to comply with any federal mandate that is similar to the requirements of subsections (b), (c), (d), (e), and (f) of G.S. 62-133.7.

(7) The fuel cost component of other purchased power.

(8) Cost of fuel and fuel-related costs shall be adjusted for any net gains or losses resulting from any sales by the electric public utility of fuel and other fuel-related costs components.

(9) Cost of fuel and fuel-related costs shall be adjusted for any net gains or losses resulting from any sales by the electric public utility of by-products produced in the generation process to the extent the costs of the inputs leading to that by-product are costs of fuel or fuel-related costs.

(a2) For those costs identified in subdivisions (4), (5), and (6) of subsection (a1) of this section, the annual increase in the aggregate amount of these costs that are recoverable by an electric public utility pursuant to this section shall not exceed two percent (2%) of the electric public utility's total North Carolina retail jurisdictional gross revenues for the preceding calendar year. The costs described in subdivisions (4), (5), and (6) of subsection (a1) of this section shall be recoverable from each class of customers as a separate component of the rider as follows:

(1) For the costs described in subdivision (4) of subsection (a1) of this section, the specific component for each class of customers shall be determined by allocating these costs among customer classes based on the electric public utility's North Carolina energy usage for the prior year, as determined by the Commission, until the Commission determines how these costs shall be allocated in a general rate case for the electric public utility commenced on or after 1 January 2008.

(2) For the costs described in subdivisions (5) and (6) of subsection (a1) of this section, the specific component for each class of customers shall be determined by allocating these costs among customer classes based on the electric public utility's North Carolina peak demand for the prior year, as determined by the Commission, until the Commission determines how these costs shall be allocated in a general rate case for the electric public utility commenced on or after 1 January 2008.

(a3) Notwithstanding subsections (a1) and (a2) of this section, for an electric public utility that has fewer than 150,000 North Carolina retail jurisdictional customers as of 31 December 2006, the costs identified in subdivisions (1), (2), (6), and (7) of subsection (a1) of this section and the fuel cost component, as may be modified by the Commission, of electric power purchases identified in subdivision (4) of subsection (a1) of this section shall be recovered through the increment or decrement rider approved by the Commission pursuant to this section. For the costs identified in subdivision (6) of subsection (a1) of this section that are incurred on or after 1 January 2008, the annual increase in the amount of these costs shall not exceed one percent (1%) of the electric public utility's total North Carolina retail jurisdictional gross revenues for the preceding calendar year. These costs described in subdivision (6) of subsection (a1) of this section shall be recoverable from each class of customers as a separate component of the rider. For the costs described in subdivision (6) of subsection (a1) of this section, the specific

component for each class of customers shall be determined by allocating these costs among customer classes based on the electric public utility's North Carolina peak demand for the prior year, as determined by the Commission, until the Commission determines how these costs shall be allocated in a general rate case for the electric public utility commenced on or after 1 January 2008.

(b) ~~For each electric utility engaged in the generation and production of electric power by fossil or nuclear fuels, the~~The Commission shall ~~hold~~ conduct a hearing within 12 months of ~~the~~ each electric public utility's last general rate case order ~~and~~ to determine whether an increment or decrement rider is required to reflect actual changes in the cost of fuel ~~and the fuel cost component of purchased power~~and fuel-related costs over or under the cost of fuel and fuel-related costs on a kilowatt-hour basis in base rates established in the electric public utility's last preceding general rate case. Additional hearings shall be held on an annual basis but only one hearing for each ~~such~~ electric public utility may be held within 12 months of the last general rate case.

(c) Each electric public utility shall submit to the Commission for the hearing verified annualized information and data in such form and detail as the Commission may require, for an historic 12-month test period, relating to:

(1) ~~Purchased cost~~Cost of fuel and fuel-related costs used in each generating facility owned in whole or in part by the utility.
(2) Fuel procurement practices and fuel inventories for each facility.
(3) Burned cost of fuel used in each generating facility.
(4) Plant capacity factor for each generating facility.
(5) Plant availability factor for each generating plant.
(6) Generation mix by types of fuel used.
(7) Sources and fuel cost component of purchased power used.
(8) Recipients of and revenues received for power sales and times of power sales.
(9) Test period ~~kilowatt hour~~kilowatt-hour sales for the utility's total system and on the total system separated for North Carolina jurisdictional sales.
(10) Procurement practices and inventories for: fuel burned and for ammonia, lime, limestone, urea, dibasic acid, sorbents, and catalysts consumed in reducing or treating emissions.
(11) The cost incurred at each generating facility of fuel burned and of ammonia, lime, limestone, urea, dibasic acid, sorbents, and catalysts consumed in reducing or treating emissions.
(12) Any net gains or losses resulting from any sales by the electric public utility of fuel or other fuel-related costs components.
(13) Any net gains or losses resulting from any sales by the electric public utility of by-products produced in the generation process to the extent the costs of the inputs leading to that by-product are costs of fuel or fuel-related costs.

(d) The Commission shall provide for notice of a public hearing with reasonable and adequate time for investigation and for all intervenors to prepare for hearing. At the hearing the Commission shall receive evidence from the utility, the ~~public staff,~~Public Staff, and any intervenor desiring to submit evidence, and from the public generally. In reaching its decision, the Commission shall consider all evidence required under subsection (c) of this section as well as any and all other competent evidence that may assist the Commission in reaching its decision including changes in the ~~price of fuel consumed and changes in the price of the fuel in the fuel component of purchased power occurring within a reasonable time (as determined by the Commission) after the test period is closed.~~cost of fuel consumed and fuel-related costs that occur within a reasonable time, as determined by the Commission, after the test period is closed. The Commission shall incorporate in its ~~fuel~~ cost of fuel and fuel-related costs determination under this subsection the experienced over-recovery or under-recovery of reasonable

costs of fuel and fuel-related costs ~~expenses~~ prudently incurred during the test period, based upon the prudent standards set pursuant to subsection (d1) of this section, in fixing an increment or decrement rider. Upon request of the electric public utility, the Commission shall also incorporate in this determination the experienced over-recovery or under-recovery of costs of fuel and fuel-related costs through the date that is 30 calendar days prior to the date of the hearing, provided that the reasonableness and prudence of these costs shall be subject to review in the utility's next annual hearing pursuant to this section. The Commission shall use deferral accounting, and consecutive test periods, in complying with this subsection, and the over-recovery or under-recovery portion of the increment or decrement shall be reflected in rates for 12 months, notwithstanding any changes in the base fuel cost in a general rate case. The burden of proof as to the correctness and reasonableness of the charge and as to whether the cost of fuel ~~charges~~ and fuel-related costs were reasonably and prudently incurred shall be on the utility. The Commission shall allow only that portion, if any, of a requested cost of fuel and fuel-related costs adjustment that is based on adjusted and reasonable cost of fuel ~~expenses~~ and fuel-related costs prudently incurred under efficient management and economic operations. In evaluating whether cost of fuel ~~expenses~~ and fuel-related costs were reasonable and prudently incurred, the Commission shall apply the rule adopted pursuant to subsection ~~(d1).~~(d1) of this section. To the extent that the Commission determines that an increment or decrement to the rates of the utility due to changes in the cost of fuel and ~~the fuel cost component of purchased power~~fuel-related costs over or under base fuel costs established in the preceding general rate case is just and reasonable, the Commission shall order that the increment or decrement become effective for all sales of electricity and remain in effect until changed in a subsequent general rate case or annual proceeding under this section.

(d1) Within one year after ratification of this act, for the purposes of setting ~~fuel rates,~~cost of fuel and fuel-related costs rates, the Commission shall adopt a rule that establishes prudent standards and procedures with which it can appropriately measure management efficiency in minimizing ~~fuel~~ cost of fuel and fuel-related costs.

(e) If the Commission has not issued an order pursuant to this section within ~~120~~ 180 days of a utility's submission of annual data under subsection (c) of this section, the utility may place the requested cost of fuel and fuel-related costs adjustment into effect. If the change in rate is finally determined to be excessive, the utility shall make refund of any excess plus interest to its customers in a manner ordered by the Commission.

(f) Nothing in this section shall relieve the Commission from its duty to consider the reasonableness of ~~fuel expenses~~the cost of fuel and fuel-related costs in a general rate case and to set rates reflecting reasonable ~~fuel expenses~~cost of fuel and fuel-related costs pursuant to G.S. 62-133. Nothing in this section shall invalidate or preempt any condition adopted by the Commission and accepted by the utility in any proceeding that would limit the recovery of costs by any electric public utility under this section.

(g) ~~On July 1, 1993 and every two years thereafter,~~On 1 July of every odd-numbered year, the Utilities Commission shall provide a report to the Joint Legislative Utility Review Committee summarizing the ~~procedures~~ proceedings conducted pursuant to ~~G.S. 62-133.2~~this section during the preceding two years."

SECTION 6. G.S. 62-110.1 reads as rewritten:

"**§ 62-110.1. Certificate for construction of generating facility; analysis of long-range needs for expansion of ~~facilities.~~facilities; ongoing review of construction costs; inclusion of approved construction costs in rates.**

(a) Notwithstanding the proviso in G.S. 62-110, no public utility or other person shall begin the construction of any steam, water, or other facility for the generation of electricity to be directly or indirectly used for the furnishing of public utility service, even though the facility be for furnishing the service already being rendered, without first obtaining from the Commission a certificate that public convenience and necessity requires, or will require, such construction.

(b) For the purpose of subsections (a), (c), and (d) of this section, "public utility" shall include any electric membership corporation operating within this State, and the term "public utility service" shall include the service rendered by any such electric membership corporation.

(c) The Commission shall develop, publicize, and keep current an analysis of the long-range needs for expansion of facilities for the generation of electricity in North Carolina, including its estimate of the probable future growth of the use of electricity, the probable needed generating reserves, the extent, size, mix and general location of generating plants and arrangements for pooling power to the extent not regulated by the Federal ~~Power~~ Energy Regulatory Commission and other arrangements with other utilities and energy suppliers to achieve maximum efficiencies for the benefit of the people of North Carolina, and shall consider such analysis in acting upon any petition by any utility for construction. In developing such analysis, the Commission shall confer and consult with the public utilities in North Carolina, the utilities commissions or comparable agencies of neighboring states, the Federal ~~Power~~ Energy Regulatory Commission, the Southern Growth Policies Board, and other agencies having relevant information and may participate as it deems useful in any joint boards investigating generating plant sites or the probable need for future generating facilities. In addition to such reports as public utilities may be required by statute or rule of the Commission to file with the Commission, any such utility in North Carolina may submit to the Commission its proposals as to the future needs for electricity to serve the people of the State or the area served by such utility, and insofar as practicable, each such utility and the Attorney General may attend or be represented at any formal conference conducted by the Commission in developing a plan for the future requirements of electricity for North Carolina or this region. In the course of making the analysis and developing the plan, the Commission shall conduct one or more public hearings. Each year, the Commission shall submit to the Governor and to the appropriate committees of the General Assembly a report of its analysis and plan, the progress to date in carrying out such plan, and the program of the Commission for the ensuing year in connection with such plan.

(d) In acting upon any petition for the construction of any facility for the generation of electricity, the Commission shall take into account the applicant's arrangements with other electric utilities for interchange of power, pooling of plant, purchase of power and other methods for providing reliable, ~~efficient~~ efficient, and economical electric service.

(e) As a condition for receiving ~~such certificate~~ a certificate, the applicant shall file an estimate of construction costs in such detail as the Commission may require. The Commission shall hold a public hearing on each ~~such~~ application and no certificate shall be granted unless the Commission has approved the estimated construction costs and made a finding that ~~such~~ construction will be consistent with the Commission's plan for expansion of electric generating capacity. A certificate for the construction of a coal or nuclear facility shall be granted only if the applicant demonstrates and the Commission finds that energy efficiency measures; demand-side management; renewable energy resource generation; combined heat and power generation; or any combination thereof, would not establish or maintain a more cost-effective and reliable generation system and that the construction and operation of the facility is in the public interest. In making its determination, the Commission shall consider resource and fuel diversity and reasonably anticipated future operating costs. Once the Commission grants a certificate, no public utility shall cancel construction of a generating unit or facility without approval from the Commission based upon a finding that the construction is no longer in the public interest.

(e1) Upon the request of the public utility or upon its own motion, the Commission may review the certificate to determine whether changes in the probable future growth of the use of electricity indicate that the public convenience and necessity require modification or revocation of the certificate. If the Commission finds that

completion of the generating facility is no longer in the public interest, the Commission may modify or revoke the certificate.

(f) ~~The Commission shall maintain an ongoing review of such construction as it proceeds and the applicant shall submit each year during construction a progress report and any revisions in the cost estimates for the construction.~~ The public utility shall submit a progress report and any revision in the cost estimate for the construction approved under subsection (e) of this section during each year of construction. Upon the request of the public utility or upon its own motion, the Commission may conduct an ongoing review of construction of the facility as the construction proceeds. If the Commission approves any revised construction cost estimate and finds that incurrence of the cost of that portion of the construction of the facility under review was reasonable and prudent, the certificate shall remain in effect. If the Commission disapproves any part of the revised cost estimate or finds that the incurrence of the cost of that portion of the construction of the facility then under review was unreasonable or imprudent, the Commission may modify or revoke the certificate.

(f1) The public utility shall recover through rates in a general rate case conducted pursuant to G.S. 62-133 the actual costs it has incurred in constructing a generating facility in reliance on a certificate issued under this section as provided in this subsection, unless new evidence is discovered (i) that could not have been discovered by due diligence at an earlier time and (ii) that reasonably tends to show that a previous determination by the Commission that a material item of cost was just and reasonable and prudently incurred was erroneous. If the Commission determines that evidence has been submitted that meets the requirements of this subsection, the public utility shall have the burden of proof to demonstrate that the material item of cost was in fact just and reasonable and prudently incurred.

(1) When a facility has been completed, and the construction of the facility has been subject to ongoing review under subsection (f) of this section, the reasonable and prudent costs of construction approved by the Commission during the ongoing review shall be included in the public utility's rate base without further review by the Commission.

(2) If a facility has not been completed, and the construction of the facility has been subject to ongoing review under subsection (f) of this section, the reasonable and prudent costs of construction approved by the Commission during the ongoing review shall be included in the public utility's rate base without further review by the Commission.

(3) If a facility is under construction or has been completed and the construction of the facility has not been subject to ongoing review under subsection (f) of this section, the costs of construction shall be included in the public utility's rate base if the Commission finds that the incurrence of these costs is reasonable and prudent.

(f2) If the construction of a facility is cancelled, including cancellation as a result of modification or revocation of the certificate under subsection (e1) of this section, and the construction of the facility has been subject to ongoing review under subsection (f), absent newly discovered evidence (i) that could not have been discovered by due diligence at an earlier time and (ii) that reasonably tends to show that a previous determination by the Commission that a material item of cost was just and reasonable and prudently incurred was erroneous, the public utility shall recover through rates in a general rate case conducted pursuant to G.S. 62-133 the costs of construction approved by the Commission during the ongoing review that were actually incurred prior to cancellation, amortized over a reasonable time as determined by the Commission. In the general rate case, the Commission shall make any adjustment that may be required because costs of construction previously added to the utility's rate base pursuant to subsection (f1) of this section are removed from the rate base and recovered in accordance with this subsection. Any costs of construction actually incurred, but not previously approved by the Commission, shall be recovered only if they are found by

the Commission to be reasonable and prudent. If the Commission determines that evidence has been submitted that meets the requirements of this subsection, the public utility shall have the burden of proof to demonstrate that the material item of cost was just and reasonable and prudently incurred.

(f3) If the construction of a facility is cancelled, including cancellation as a result of the modification or revocation of the certificate under subsection (e1) of this section, and the construction of the facility has not been subject to ongoing review under subsection (f) of this section, the public utility shall recover through rates in a general rate case conducted pursuant to G.S. 62-133 the costs of construction that were actually incurred prior to the cancellation and are found by the Commission to be reasonable and prudent, amortized over a reasonable time as determined by the Commission. In the general rate case, the Commission shall make any adjustment that may be required because costs of construction previously added to the utility's rate base pursuant to subsection (f1) of this section are removed from the rate base and recovered in accordance with this subsection.

(g) The certification requirements of this section shall not apply to a nonutility-owned generating facility fueled by renewable energy resources under two megawatts in capacity or to persons who construct an electric generating facility primarily for that person's own use and not for the primary purpose of producing electricity, heat, or steam for sale to or for the public for compensation; provided, however, that such persons shall, nevertheless, be required to report to the Utilities Commission the proposed construction of such a facility before beginning construction thereof."

SECTION 7. Article 6 of Chapter 62 of the General Statutes is amended by adding two new sections to read:

"**§ 62-110.6. Rate recovery for construction costs of out-of-state electric generating facilities.**

(a) The Commission shall, upon petition of a public utility, determine the need for and, if need is established, approve an estimate of the construction costs and construction schedule for an electric generating facility in another state that is intended to serve retail customers in this State.

(b) The petition may be filed at any time after an application for a certificate or license for the construction of the facility has been filed in the state in which the facility will be sited. The petition shall contain a showing of need for the facility, an estimate of the construction costs, and the proposed construction schedule for the facility.

(c) The Commission shall conduct a public hearing to consider and determine the need for the facility and the reasonableness of the construction cost estimate and proposed construction schedule. If the Commission finds that the construction will be needed to assure the provision of adequate public utility service within North Carolina, the Commission shall approve a construction cost estimate and a construction schedule for the facility. In making its determinations under this section, the Commission may consider whether the state in which the facility will be sited has issued a certificate or license for construction of the facility and approved a construction cost estimate and construction schedule for the facility. The Commission shall issue its order not later than 180 days after the public utility files its petition.

(d) G.S. 62-110.1(f) shall apply to the construction cost estimate determined by the Commission to be appropriate, and the actual costs the public utility incurs in constructing the facility shall be recoverable through rates in a general rate case pursuant to G.S. 62-133 as provided in G.S. 62-110.1(f1).

(e) If the construction of a facility is cancelled, the public utility shall recover through rates in a general rate case conducted pursuant to G.S. 62-133 the costs of construction that were actually incurred prior to the cancellation and are found by the Commission to be reasonable and prudent, as provided in subsections (f2) and (f3) of G.S. 62-110.1.

"**§ 62-110.7. Project development cost review for a nuclear facility.**

(a) For purposes of this section, "project development costs" mean all capital costs associated with a potential nuclear electric generating facility incurred before (i) issuance of a certificate under G.S. 62-110.1 for a facility located in North Carolina or (ii) issuance of a certificate by the host state for an out-of-state facility to serve North Carolina retail customers, including, without limitation, the costs of evaluation, design, engineering, environmental analysis and permitting, early site permitting, combined operating license permitting, initial site preparation costs, and allowance for funds used during construction associated with such costs.

(b) At any time prior to the filing of an application for a certificate to construct a potential nuclear electric generating facility, either under G.S. 62-110.1 or in another state for a facility to serve North Carolina retail customers, a public utility may request that the Commission review the public utility's decision to incur project development costs. The public utility shall include with its request such information and documentation as is necessary to support approval of the decision to incur proposed project development costs. The Commission shall hold a hearing regarding the request. The Commission shall issue an order within 180 days after the public utility files its request. The Commission shall approve the public utility's decision to incur project development costs if the public utility demonstrates by a preponderance of evidence that the decision to incur project development costs is reasonable and prudent; provided, however, the Commission shall not rule on the reasonableness or prudence of specific project development activities or recoverability of specific items of cost.

(c) All reasonable and prudent project development costs, as determined by the Commission, incurred for the potential nuclear electric generating facility shall be included in the public utility's rate base and shall be fully recoverable through rates in a general rate case proceeding pursuant to G.S. 62-133.

(d) If the public utility is allowed to cancel the project, the Commission shall permit the public utility to recover all reasonable and prudently incurred project development costs in a general rate case proceeding pursuant to G.S. 62-133 amortized over a period equal to the period during which the costs were incurred, or five years, whichever is greater."

SECTION 8. G.S. 62-133(b) reads as rewritten:

"(b) In fixing such rates, the Commission shall:

(1) Ascertain the reasonable original cost of the public utility's property used and useful, or to be used and useful within a reasonable time after the test period, in providing the service rendered to the public within the State, less that portion of the cost ~~which~~ that has been consumed by previous use recovered by depreciation ~~expense plus the reasonable original cost of investment in plant under construction (construction work in progress). In ascertaining the cost of the public utility's property, construction work in progress as of the effective date of this subsection shall be excluded until such plant comes into service but reasonable and prudent expenditures for construction work in progress after the effective date of this subsection may be included, to the extent the Commission considers such inclusion in the public interest and necessary to the financial stability of the utility in question, subject to the provisions of subparagraph (b)(4a) of this section.~~expense. In addition, construction work in progress may be included in the cost of the public utility's property under any of the following circumstances:

a. To the extent the Commission considers inclusion in the public interest and necessary to the financial stability of the utility in question, reasonable and prudent expenditures for construction work in progress may be included, subject to the provisions of subdivision (4a) of this subsection.

b. For baseload electric generating facilities, reasonable and prudent expenditures shall be included pursuant to subdivisions

(2) or (3) of G.S. 62-110.1(f1), whichever applies, subject to the provisions of subdivision (4a) of this subsection.

(1a) Apply the rate of return established under subdivision (4) of this subsection to rights-of-way acquired through agreements with the Department of Transportation pursuant to G.S. 136-19.5(a) if acquisition is consistent with a definite plan to provide service within five years of the date of the agreement and if such right-of-way acquisition will result in benefits to the ratepayers. If a right-of-way is not used within a reasonable time after the expiration of the five-year period, it may be removed from the rate base by the Commission when rates for the public utility are next established under this section.

(2) Estimate such public utility's revenue under the present and proposed rates.

(3) Ascertain such public utility's reasonable operating expenses, including actual investment currently consumed through reasonable actual depreciation.

(4) Fix such rate of return on the cost of the property ascertained pursuant to subdivision (1) of this subsection as will enable the public utility by sound management to produce a fair return for its shareholders, considering changing economic conditions and other factors, including, but not limited to, the inclusion of construction work in progress in the utility's property under sub-subdivision b. of subdivision (1) of this subsection, as they then exist, to maintain its facilities and services in accordance with the reasonable requirements of its customers in the territory covered by its franchise, and to compete in the market for capital funds on terms ~~which~~ that are reasonable and ~~which~~ that are fair to its customers and to its existing investors.

(4a) Require each public utility to discontinue capitalization of the composite carrying cost of capital funds used to finance construction (allowance for funds) on the construction work in progress included in its rate based upon the effective date of the first and each subsequent general rate order issued with respect to it after the effective date of this subsection; allowance for funds may be capitalized with respect to expenditures for construction work in progress not included in the utility's property upon which the rates were fixed. In determining net operating income for return, the Commission shall not include any capitalized allowance for funds used during construction on the construction work in progress included in the utility's rate base.

(5) Fix such rates to be charged by the public utility as will earn in addition to reasonable operating expenses ascertained pursuant to subdivision (3) of this subsection the rate of return fixed pursuant to subdivisions (4) and (4a) on the cost of the public utility's property ascertained pursuant to subdivisions (1) and (1a) of this subsection."

SECTION 9.(a) The percentage rate to be used in calculating the public utility regulatory fee under G.S. 62-302(b)(2) is twelve one-hundredths of one percent (0.12%) for each public utility's North Carolina jurisdictional revenues earned during each quarter that begins on or after 1 July 2007.

SECTION 9.(b) The electric membership corporation regulatory fee imposed under G.S. 62-302(b1) for the 2007-2008 fiscal year is two hundred thousand dollars ($200,000).

SECTION 10.(a) G.S. 105-164.4(a)(1i) is repealed.

SECTION 10.(b) G.S. 105-164.4(a)(1f) reads as rewritten:

"(a) A privilege tax is imposed on a retailer at the following percentage rates of the retailer's net taxable sales or gross receipts, as appropriate. The general rate of tax is four and one-quarter percent (4.25%).

...

(1f) The rate of two and eighty-three-hundredths percent (2.83%) applies to the sales price of electricity ~~described in this subdivision and~~ that is measured by a separate meter or another separate ~~device:~~device and sold to a commercial laundry or to a pressing and dry-cleaning establishment for use in machinery used in the direct performance of the laundering or the pressing and cleaning service.

~~a. Sales of electricity to farmers to be used by them for any farm purposes other than preparing food, heating dwellings, and other household purposes. The quantity of electricity or gas purchased or used at any one time shall not be a determinative factor as to whether its sale or use is or is not subject to the rate of tax provided in this subdivision.~~

b. Repealed.

~~c. Sales of electricity to commercial laundries or to pressing and dry-cleaning establishments for use in machinery used in the direct performance of the laundering or the pressing and cleaning service.~~"

SECTION 10.(c) G.S. 105-164.4(a) is amended by adding a new subdivision to read:

"(a) A privilege tax is imposed on a retailer at the following percentage rates of the retailer's net taxable sales or gross receipts, as appropriate. The general rate of tax is four and one-quarter percent (4.25%).

...

(1j) The rate of one and eight-tenths percent (1.8%) applies to the sales price of electricity described in this subdivision and measured by a separate meter or another separate device:

a. Sales of electricity to manufacturing industries and manufacturing plants for use in connection with the operation of the industries and plants.

b. Sales of electricity to farmers to be used by them for any farming purposes other than preparing food, heating dwellings, and other household purposes."

SECTION 10.(d) G.S. 105-164.4(a)(1j), as enacted by subsection (c) of this section, reads as rewritten:

"(1j) The rate of ~~one and eight-tenths percent (1.8%)~~ one and four-tenths percent (1.4%) applies to the sales price of electricity described in this subdivision and measured by a separate meter or another separate device:

a. Sales of electricity to manufacturing industries and manufacturing plants for use in connection with the operation of the industries and plants.

b. Sales of electricity to farmers to be used by them for any farming purposes other than preparing food, heating dwellings, and other household purposes."

SECTION 10.(e) G.S. 105-164.4(a)(1j), as enacted by subsection (c) of this section and amended by subsection (d) of this section, reads as rewritten:

"(1j) The rate of ~~one and four-tenths percent (1.4%)~~ eight-tenths percent (0.8%) applies to the sales price of electricity described in this subdivision and measured by a separate meter or another separate device:

a. Sales of electricity to manufacturing industries and manufacturing plants for use in connection with the operation of the industries and plants.
b. Sales of electricity to farmers to be used by them for any farming purposes other than preparing food, heating dwellings, and other household purposes."

SECTION 10.(f) G.S. 105-164.4(a)(1j), as enacted by this section, is repealed.

SECTION 10.(g) G.S. 105-164.13(1) reads as rewritten:

"**§ 105-164.13. Retail sales and use tax.**

The sale at retail and the use, storage, or consumption in this State of the following tangible personal property and services are specifically exempted from the tax imposed by this Article:

Agricultural Group.

(1) Any of the following items sold to a farmer for use by the farmer in the planting, cultivating, harvesting, or curing of farm crops or in the production of dairy products, eggs, or animals. A "farmer" includes a dairy operator, a poultry farmer, an egg producer, a livestock farmer, a farmer of crops, and a farmer of an aquatic species, as defined in G.S. 106-758.
a. Commercial fertilizer, lime, land plaster, plastic mulch, plant bed covers, potting soil, and seeds.
b. Farm machinery, attachment and repair parts for farm machinery, and lubricants applied to farm machinery. The term "machinery" includes implements that have moving parts or are operated or drawn by an animal. The term does not include implements operated wholly by hand or motor vehicles required to be registered under Chapter 20 of the General Statutes.
c. A horse or mule.
d. ~~Fuel other than electricity.~~Fuel."

SECTION 10.(h) G.S. 105-164.13 is amended by adding two new subdivisions to read:

"**§ 105-164.13. Retail sales and use tax.**

The sale at retail and the use, storage, or consumption in this State of the following tangible personal property and services are specifically exempted from the tax imposed by this Article:

...

(1b) Electricity sold to a farmer to be used for any farming purpose other than preparing food, heating dwellings, and other household purposes.

...

(56) Fuel and electricity sold to a manufacturer for use in connection with the operation of a manufacturing facility."

SECTION 10.(i) Subsections (a), (b), and (c) of this section become effective 1 October 2007 and apply to sales occurring on or after that date. Subsection (d) of this section becomes effective 1 July 2008 and applies to sales occurring on or after that date. Subsection (e) of this section becomes effective 1 July 2009 and applies to sales occurring on or after that date. Subsections (f), (g), and (h) of this section become effective 1 July 2010 and apply to sales occurring on or after that date. The remainder of this section is effective when it becomes law.

SECTION 11.(a) G.S. 105-187.41 reads as rewritten:

"**§ 105-187.41. Tax imposed on piped natural gas.**

(a) Scope. – An excise tax is imposed on piped natural gas received for consumption in this State. This tax is imposed in lieu of a sales and use tax and a percentage gross receipts tax on piped natural gas.

(b) Rate. – The tax rate is set in the table below. The tax rate is based on monthly therm volumes of piped natural gas received by the end-user of the gas. If an end-user receives piped natural gas that is metered through two or more separate measuring devices, the tax is calculated separately on the volume metered through each device rather than on the total volume metered through all measuring devices, unless the devices are located on the same premises and are part of the same billing account. In that circumstance, the tax is calculated on the total volume metered through the two or more separate measuring devices.

Monthly Volume of Therms Received	Rate Per Therm
First 200	$.047
201 to 15,000	.035
15,001 to 60,000	.024
60,001 to 500,000	.015
Over 500,000	.003

(c) Gas City Exemption. – The tax imposed by this section does not apply to piped natural gas received by a gas city for consumption by that city or to piped natural gas delivered by a gas city to a sales or transportation customer of the gas city.

(d) Reduced Rate. – Piped natural gas received by a manufacturer for use in connection with the operation of a manufacturing facility or by a farmer to be used for any farming purpose other than preparing food, heating dwellings, and other household purposes is taxable at a reduced rate as provided in this subsection. To be eligible for the reduced tax rate, a person must have a manufacturer's certificate or a farmer's certificate issued under G.S. 105-164.28A. A person who uses piped natural gas for an unauthorized purpose is liable for any tax due on the gas.

Monthly Volume of Therms Received	Rate Per Therm
First 200	$.032
201 to 15,000	.024
15,001 to 60,000	.016
60,001 to 500,000	.010
Over 500,000	.002"

SECTION 11.(b) G.S. 105-187.41(d), as enacted by subsection (a) of this section, reads as rewritten:

"(d) Reduced Rate. – Piped natural gas received by a manufacturer for use in connection with the operation of a manufacturing facility and by a farmer to be used for any farming purpose other than preparing food, heating dwellings, and other household purposes is taxable as provided in this subsection. To be eligible for the reduced tax rate, a person must have a manufacturer's certificate or a farmer's certificate issued under G.S. 105-164.28A. A person who uses piped natural gas for an unauthorized purpose is liable for any tax due on the gas.

Monthly Volume of Therms Received	Rate Per Therm
First 200	~~$.032~~.025
201 to 15,000	~~.024~~.019
15,001 to 60,000	~~.016~~.013
60,001 to 500,000	~~.010~~.008
Over 500,000	~~.002~~.002"

SECTION 11.(c) G.S. 105-187.41(d), as enacted by subsection (a) of this section and amended by subsection (b) of this section, reads as rewritten:

"(d) Reduced Rate. – Piped natural gas received by a manufacturer for use in connection with the operation of a manufacturing facility and by a farmer to be used for

any farming purpose other than preparing food, heating dwellings, and other household purposes is taxable as provided in this subsection. To be eligible for the reduced tax rate, a person must have a manufacturer's certificate or a farmer's certificate issued under G.S. 105-164.28A. A person who uses piped natural gas for an unauthorized purpose is liable for any tax due on the gas.

Monthly Volume of Therms Received	Rate Per Therm
First 200	~~$.025~~.014
201 to 15,000	~~.019~~.010
15,001 to 60,000	~~.013~~.007
60,001 to 500,000	~~.008~~.004
Over 500,000	~~.002~~.001"

SECTION 11.(d) G.S. 105-187.41(d), as enacted by this section, is repealed.

SECTION 11.(e) G.S. 105-187.41(c) reads as rewritten:

"(c) ~~Gas City Exemption.~~ Exemptions. – The tax imposed by this section does not apply to ~~piped~~ any of the following:

(1) Piped natural gas received by a gas city for consumption by that ~~city or to piped~~ city.

(2) Piped natural gas delivered by a gas city to a sales or transportation customer of the gas city.

(3) Piped natural gas received by a manufacturer for use in connection with the operation of the manufacturing facility. To be eligible for the exemption, a person must have a manufacturer's certificate issued under G.S. 105-164.28A. A person who uses piped natural gas for an unauthorized purpose is liable for any tax due on the gas.

(4) Piped natural gas received by a farmer to be used for any farming purpose other than preparing food, heating dwellings, and other household purposes. To be eligible for the exemption, a person must have a farmer's certificate issued under G.S. 105-164.28A. A person who uses piped natural gas for an unauthorized purpose is liable for any tax due on the gas."

SECTION 11.(f) Subsection (a) of this section becomes effective 1 October 2007 and applies to bills issued on or after that date. Subsection (b) of this section becomes effective 1 July 2008 and applies to bills issued on or after that date. Subsection (c) of this section becomes effective 1 July 2009 and applies to bills issued on or after that date. Subsections (d) and (e) of this section become effective 1 July 2010 and apply to bills issued on or after that date. The remainder of this section is effective when it becomes law.

SECTION 12.(a) G.S. 105-187.51A reads as rewritten:

"**§ 105-187.51A. Tax imposed on manufacturing fuel.**

A privilege tax is imposed on a manufacturing industry or plant that purchases fuel to operate the industry or plant. The tax is ~~one percent (1%)~~ seven-tenths percent (0.7%) of the sales price of the fuel. The tax does not apply to electricity or piped natural gas."

SECTION 12.(b) G.S. 105-187.51A, as amended by subsection (a) of this section, reads as rewritten:

"**§ 105-187.51A. Tax imposed on manufacturing fuel.**

A privilege tax is imposed on a manufacturing industry or plant that purchases fuel to operate the industry or plant. The tax is ~~seven-tenths percent~~ five-tenths percent (0.5%) of the sales price of the fuel. The tax does not apply to electricity or piped natural gas."

SECTION 12.(c) G.S. 105-187.51A, as amended by subsection (a) of this section, reads as rewritten:

"**§ 105-187.51A. Tax imposed on manufacturing fuel.**

A privilege tax is imposed on a manufacturing industry or plant that purchases fuel to operate the industry or plant. The tax is ~~five-tenths percent (0.5%)~~ three-tenths

percent (0.3%) of the sales price of the fuel. The tax does not apply to electricity or piped natural gas."

SECTION 12.(d) G.S. 105-187.51A is repealed.

SECTION 12.(e) Subsection (a) of this section becomes effective 1 October 2007 and applies to fuel purchased on or after that date. Subsection (b) of this section becomes effective 1 July 2008 and applies to fuel purchased on or after that date. Subsection (c) of this section becomes effective 1 July 2009 and applies to fuel purchased on or after that date. Subsection (d) of this section becomes effective 1 July 2010. The remainder of this section is effective when it becomes law.

SECTION 13.(a) Article 3B of Chapter 105 of the General Statutes is amended by adding a new section to read:

"**§ 105-129.16G. Credit for donating funds to a nonprofit organization to enable the nonprofit to acquire renewable energy property.**

(a) Credit. – A taxpayer who donates money to a tax-exempt nonprofit organization for the purpose of providing funds for the organization to construct, purchase, or lease renewable energy property is allowed a credit under this section if the nonprofit organization uses the donation for its intended purpose. A tax-exempt nonprofit organization is an organization that is exempt from tax under section 501(c)(3) of the Code.

The amount of the credit allowed in this section is the taxpayer's share of the credit the nonprofit organization could claim under G.S. 105-129.16A if the nonprofit organization were subject to tax. The taxpayer's share of the credit is calculated by dividing the taxpayer's donation by the cost of the renewable energy property constructed, purchased, or leased by the nonprofit organization and placed in service during the taxable year and then multiplying this percentage by the amount of the credit the nonprofit organization could claim if it were subject to tax. A taxpayer must take the credit allowed by this section in the year in which the property is placed in service. The installment requirements in G.S. 105-129.16A for nonresidential property do not apply to the credit allowed in this section.

(b) Records. – A nonprofit organization must keep a record of all donations it receives for the purpose of providing funds for the organization to construct, purchase, or lease renewable energy property and of the amount of the donations used for this purpose. If a nonprofit organization places renewable energy property in service that is purchased in whole or in part from donations made for this purpose, the nonprofit organization must give each taxpayer who made a donation a statement setting out the amount of the credit for which the taxpayer qualifies under this section. The statement must describe the renewable energy property placed in service and state the cost of the property, the amount of the credit the nonprofit organization could claim under G.S. 105-129.16A if it were subject to tax, and the taxpayer's share of the credit allowed in this section. If the donations made for the renewable energy property exceed the cost of the property, the nonprofit organization must prorate each taxpayer's share of the credit. The sum of the credits allowed under this section to taxpayers who make donations to a nonprofit organization may not exceed the amount of the credit the nonprofit organization could claim under G.S. 105-129.16A if it were subject to tax.

(c) No Double Benefit. – A taxpayer who claims a credit under this section based on a donation to a nonprofit organization is not allowed to deduct this donation as a charitable contribution."

SECTION 13.(b) G.S. 105-130.5(a) is amended by adding a new subdivision to read:

"(a) The following additions to federal taxable income shall be made in determining State net income:

...

(19) The amount of a donation made to a nonprofit organization for which a credit is claimed under G.S. 1105-129.16G."

SECTION 13.(c) G.S. 105-134.6(c) is amended by adding a new subdivision to read:

"(c) Additions. – The following additions to taxable income shall be made in calculating North Carolina taxable income, to the extent each item is not included in taxable income:

...

(5b) The amount of a donation made to a nonprofit organization for which a credit is claimed under G.S. 105-129.16G."

SECTION 13.(d) G.S. 105-259(b) is amended by adding a new section to read:

"(b) Disclosure Prohibited. – An officer, an employee, or an agent of the State who has access to tax information in the course of service to or employment by the State may not disclose the information to any other person unless the disclosure is made for one of the following purposes:

...

(38) To verify with a nonprofit organization information relating to eligibility for a credit under G.S. 105-129.16G."

SECTION 13.(e) This section is effective for taxable years beginning on or after 1 January 2008.

SECTION 14. The Utilities Commission shall submit to the Governor, the Environmental Review Commission, and the Joint Legislative Utility Review Committee a report on the actual results of the cost allocations established pursuant to G.S. 62-133.7(h), as enacted by Section 2 of this act, G.S. 62-133.8(e) and G.S. 62-133.8(f), as enacted by Section 4 of this act, and G.S. 62-133.2(a2) and G.S. 62-133.2(a3), as enacted by Section 5 of this act, during the preceding two fiscal years on or before 1 October of odd-numbered years. The Utilities Commission shall submit the first report required by this section no later than 1 October 2009.

SECTION 15. If any section or provision of this act is declared unconstitutional or invalid by the courts, the unconstitutional or invalid section or provision does not affect the validity of this act as a whole or any part of this act other than the part declared to be unconstitutional or invalid.

SECTION 16. Sections 1, 2, 6, 7, and 8 of this act become effective 1 January 2008. The provisions of Section 2 of this act that provide for the recovery of costs incurred under Section 2 apply only to costs that are incurred on and after 1 January 2008. Sections 3, 4, 14, 15, and 16 of this act become effective when this act becomes law. The provisions of Section 4 of this act that provide for the recovery of costs incurred under Section 4 apply only to costs that are incurred on and after the date that this act becomes law. Section 5 of this act becomes effective 1 January 2008 provided that (i) the provisions of G.S. 62-133.2, as amended by Section 5 of this act, apply only to fuel and fuel-related costs incurred on and after 1 January 2008 regardless of the test period established by the Utilities Commission, and (ii) the costs described in G.S. 62-133.2(a1)(3) that are incurred on and after the date this act becomes law shall be recoverable as provided in G.S. 62-133.2 as amended by Section 5 of this act. Sections 10, 11, 12, and 13 of this act become effective as provided in those sections. Section 9 of this act becomes effective 1 July 2007.

In the General Assembly read three times and ratified this the 2nd day of August, 2007.

s/ Beverly E. Perdue
President of the Senate

s/ Joe Hackney
Speaker of the House of Representatives

s/ Michael F. Easley
Governor

Approved 3:20 p.m. this 20th day of August, 2007

GENERAL ASSEMBLY OF NORTH CAROLINA

Session 2007

Legislative Fiscal Note

BILL NUMBER: Senate Bill 3 (Fourth Edition)

SHORT TITLE: Promote Renewable Energy/Baseload Generation.

SPONSOR(S): Senator Albertson

FISCAL IMPACT

Yes (x) No ( ) No Estimate Available ( )

	FY 2007-08	FY 2008-09	FY 2009-10	FY 2010-11	FY 2011-12
REVENUES: ($ Millions)					
Sections 10-12 (State)	**($10.0)**	**($20.0)**	**($30.0)**	**($45.0)**	**($44.7)**
Section 13		**** See Assumptions and Methodology****			
Section 11 (municipalities)	**($2.0)**	**($3.8)**	**($5.4)**	**($7.6)**	**($7.0)**
EXPENDITURES:		**** See Assumptions and Methodology****			

PRINCIPAL DEPARTMENT(S) & PROGRAM(S) AFFECTED: Utilities Commission, Department of Revenue, State agencies, county and municipal governments

EFFECTIVE DATE: Sections 1,2,5,6,7, and 8 become effective January 1, 2008. Sections 3, 4, 15, 16 become effective when the bill becomes law. The effective date for Section 9 is July 1, 2007. Sections 10, 11, 12 and 13 become effective as provided in those sections.

BILL SUMMARY: Sections 1 through 4 of Senate Bill 3 establish a Renewable Energy and Energy Efficiency Portfolio Standard (REPS) in North Carolina that would include:

- A 12.5% REPS for electric public utilities.
- A 10% REPS for electric membership corporations and municipalities that sell electric power in the State.
- Provisions to encourage the use of solar energy, swine waste, and poultry waste resources.
- Provisions to encourage the implementation of demand-side management and energy efficiency programs.

Sections 5 through 9 amend the cost recovery procedures for electric power suppliers to provide for:

- Recovery of additional costs under the annual fuel charge.
- Ongoing review of construction costs and the inclusion of construction costs in rates.
- Recovery of construction costs for out-of-state electric generating facilities.
- Recovery of project development costs for nuclear facilities.
- Recovery of construction work in progress when reasonable and prudent and subject to an ongoing review by the Utilities Commission

Section 9 maintains the public utility and electric membership corporation regulatory fees at their current level.

Sections 10 through 12 phase out the sales taxes paid by farmers and manufacturers for electricity, piped natural gas, and other fuels.

Section 13 establishes renewable energy and energy efficiency tax credits.

Sections 15 is the severability clause, and Section 16 lays out the effective dates for various portions of the bill.

ASSUMPTIONS AND METHODOLOGY:
Sections 1 through 9 will be administered by the NC Utilities Commission, a receipt supported State entity. While the Commission may require additional staff in the future to administer this bill, any costs associated with that would be covered by receipts generated by the Commission.

Section 2(h)(4) allows for an annual rider to recover the incremental costs incurred by an electric company to comply with the REPS requirements. This charge cannot exceed the following per-account annual charges:

Customer Class	2008-2011	2012-2014	2015 and thereafter
Residential per account	$10.00	$12.00	$34.00
Commercial per account	$50.00	$150.00	$150.00
Industrial per account	$500.00	$1,000.00	$1,000.00

The bill directs the Utilities Commission to adopt rules regarding this annual assessment.

Government entities fall into the commercial class. To determine the maximum additional cost the State will pay, each utility company was asked to provide the number of government accounts they service, broken down by State, counties, and municipalities. Universities were included in the State number, while community colleges and local education agencies were included in the county figures. Three major electric companies serve the State: Duke Power Company, Progress Energy Carolinas, and Dominion North Carolina Power. In addition, there are 27 Electric Membership Corporations that provide power to rural areas throughout the State.

The bill does not specifically define "account"; however, in general, there is one account for every meter. Accounts may include buildings, stoplights, streetlights, etc. Progress Energy and Duke Energy both estimate that about half of their State accounts are stoplights. For the purposes of this estimate, it is assumed that the Utilities Commission will adopt rules excluding those types of accounts from the annual assessment. Therefore, only half of the State accounts reported by Progress Energy and Duke Energy are used to calculate the fiscal impact of the bill. It is unknown what portion of Dominion and co-op accounts may be stoplights, and none of the companies provided information regarding county and municipality stoplights, so no adjustment was made to those figures. To the extent that a portion of those figures are stoplight accounts, the cost estimate may be overestimated.

17 of the 27 Electric Membership Corporations responded to the request for information regarding the number of government accounts they serve. Of those, eight reported accounts by category (the others either reported one total, or provided a State number and a local number). To determine the estimated total number of government accounts for the remaining 10 co-ops, the percentage of active meters that are government accounts was calculated for each of the 17 co-ops that responded. The average of those percentages (0.47%) was then applied to the number of active meters for each of the remaining 10. To calculate the number of accounts by type for the 10 non-respondents and the nine co-ops that did not categorize their accounts, the number of accounts in each category for the eight that reported was totaled, and a percentage of the total for each category was determined. That percentage was then applied to the total number of accounts. To the extent that these calculations under- or over-estimated the number of accounts, the costs shown will be over- or under-estimated.

Estimated Government Accounts by Power Company

Company	State	County	Municipality
Duke Energy Carolinas	2,119	2,503	3,942
Progress Energy	2,014	3,073	4,080
Dominion NC Power	403	2083	
NC Assoc. of Electric Cooperatives	1325	1,485	504
Total Accounts	**5,861**	**9,144**	**8,526**
Per Account Cap on REPS Rider	$50	$50	$50
Estimated Maximum Expenditure	**$293,070**	**$457,209**	**$426,300**

Accounts included in the State category include State agencies and programs supported by the General Fund, Highway Fund, federal funds, or receipts. At this time, no data is available regarding how many of the reported accounts are agencies supported by the General Fund; therefore, no estimate is available regarding the impact of this section on General Fund appropriations. In addition, no data is immediately available delineating the accounts by county or specific municipality. Therefore, only an estimated aggregate amount for those account types is shown.

Section 5 allows for the recovery of additional costs under the annual fuel charge, not to exceed 2% of the electric company's total retail jurisdictional gross revenues for the preceding calendar year. No estimate is available regarding the potential cost of this section to government entities.

Section 10 would phase out the current sales tax rate of 2.6% on sales of electricity to manufacturing industries and manufacturing plants for use in connection with their operation and to farmers to be used by them for farming purposes as follows:

- Effective October 1, 2007, reduces the rate from 2.6% to 1.8%.
- Effective July 1, 2008, reduces the rate from 1.8% to 1.4%.
- Effective July 1, 2009, reduces the rate from 1.4% to 0.8%.
- Effective July 1, 2010, repeals the tax.

The general rate of tax on sales of electricity is 3%. Sales of electricity to an aluminum smelting facility are taxed at the rate of 1%, but this rate expires for sales made on or after October 1, 2007. Last session, in S.L. 2006-66, the tax on sales of electricity to manufacturing industries and manufacturing plants was reduced from 2.83% to 2.6%, effective July 1, 2007. This bill repeals the reduction enacted last session and replaces it with the 1.8% rate provided in this section of the bill. This rate applies to manufacturers and farmers. The rate is reduced to 1.4% effective July 1, 2008, 0.8% July 1, 2009 and eliminated effective July 1, 2010.

According to the Department of Revenue, the amount of tax collected in this category for FY 2005-06 was approximately $32.1 million. The amount of tax collected for FY 2006-07 is projected to be $32.9 million. The impact of phasing out the tax for future years is estimated by applying projected percentage changes in sales of electricity to the current amount of tax collected and prorating the amount of tax to account for the rate reduction.

According to the U.S. Energy Information Administration (EIA), sales of electricity in the industrial sector are projected to increase by 0.7% in FY 07-08. Similar increases are projected for the following four years. The projected percentage increase is applied for each year to project the amount of tax that would be exempted. This amount is then prorated by the percentage of the rate reduction for each year of the phase-out to determine the amount of sales tax on electricity that would be exempted under the bill.

Section 11 would phase out the tax imposed on piped natural gas received by a manufacturer for use in connection with the operation of the manufacturing facility and on piped natural gas received by a farmer to be used for any farming purpose, other than preparing food, heating dwellings, and other household purposes.

The excise tax on piped natural gas is based on a tiered rate structure. Rates are lower for those consumers who use a greater volume. The NC Public Utilities Commission reported that the excise tax on piped natural gas sold to large industrial customers generated approximately $18.6 million during FY 2005-06. A small additional amount of tax revenue is related to consumption by farmers. Natural gas providers were unable to provide an estimate for farming consumption, however, the amount of piped gas excise tax collected from farmers is expected to be less than $1 million annually. Projections for future years are based on EIA estimates for sales of natural gas. The projected amounts are then prorated to reflect a four-year phase-out.

Of the total amount of the piped gas tax collected, half of the tax attributable to activity within municipal boundaries is distributed to municipalities. The percentage of overall piped gas collections distributed to municipalities is approximately 40%. This analysis assumes that manufacturing facilities are located within municipal boundaries to a greater extent than other piped natural gas consumers and uses 45% as the portion distributed to municipalities.

Section 12 would phase out the privilege tax imposed on a manufacturing industry or plant that purchases fuel to operate the industry or plant by reducing the tax rate from 1% to 0.7%, effective July 1, 2007, from 0.7% to 0.5%, effective July 1, 2008, from 0.5% to 0.3%, effective July 1, 2009; the tax is repealed effective July 1, 2010.

Farmers are exempt from sales tax on purchases of fuel. Manufacturers are exempt from sales tax on fuel, but they are subject to a privilege tax equal to 1% of the sales price of the fuel. This section would phase that tax out over four years.

The NC Department of Revenue estimates that the privilege tax on manufacturing fuel generated approximately $2.3 million in FY 2005-06. Inflation estimates from Moody's Economy.com are used to estimate the change in tax revenue for future years. The impact of this tax exemption is also prorated to reflect the 4-year phase-out.

Section 13 would allow a tax credit to a taxpayer that makes an eligible contribution to a nonprofit organization organized under section 501(c)(3) of the Code. An eligible contribution is a contribution designated by the taxpayer to be used for investing in renewable energy property and used by the nonprofit organization for investing in renewable energy property. Renewable energy property includes the following machinery and equipment or real property:

- Biomass equipment that uses renewable biomass resources for biofuel production of ethanol, methanol, and biodiesel; anaerobic biogas production of methane utilizing agricultural and animal waste or garbage; or commercial thermal or electrical generation from renewable energy crops or wood waste materials. Renewable biomass resources are organic matters produced by terrestrial and aquatic plants and animals, such as standing vegetation, forestry and agricultural residues, landfill wastes, and animal wastes.
- Hydroelectric generators
- Solar energy equipment
- Wind equipment

The amount of the credit would be equal to a portion of the credit for investing in renewable energy property that the nonprofit organization would be allowed if the nonprofit organization was subject to tax. The amount of the credit for investing in renewable energy property is 35% of the cost of the property placed in service. The credit must be taken in five equal installments, beginning with the taxable year in which the property is placed in service. The credit may not exceed $2,500,000 per installation (the maximum credit amount is less for residential property). The portion allowed to each taxpayer is equal to the percentage of the total costs for which the nonprofit organization would have been eligible for a credit which were covered by the taxpayer's eligible contribution.

The tax credit may be taken against either the franchise tax or the individual or corporate income tax. The election is binding and any carry forwards of a credit must be claimed against the same tax. The credit may not exceed 50% of the tax against which it is claimed. Any unused portion of the credit may be carried forward for five years. The credit is effective for taxable years beginning on or after January 1, 2007. Although this credit does not have a sunset, the credit under G.S. 105-129.16A expires for renewable energy property placed into service on or after January 1, 2011.

There is no data on the number of taxpayers that might donate to nonprofits for renewable energy purposes. Likewise, the total dollars donated cannot be estimated.

SOURCES OF DATA: NC Utilities Commission; NC Department of Revenue; State Energy Office; U.S. Department of Energy; Moody's economy.com

TECHNICAL CONSIDERATIONS: Section 14 does not make clear how the portion allowed each taxpayer is to be calculated.

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DATE: July 28, 2007

Signed Copy Located in the NCGA Principal Clerk's Offices

SENATE BILL 3:
Promote Renewable Energy/Energy Efficiency

BILL ANALYSIS

Committee:		**Date:**	August 20, 2007
Introduced by:	Sen. Albertson	**Summary by:**	Jeff Hudson,
Version:	S.L. 2007-397		Staff Attorney

SUMMARY:

Senate Bill 3 would:

Establish a Renewable Energy and Energy Efficiency Portfolio Standard (REPS) in North Carolina that would include:

- ***A 12.5% REPS for electric public utilities.***
- ***A 10% REPS for electric membership corporations and municipalities that sell electric power in the State.***
- ***Provisions to encourage the use of solar energy, swine waste, and poultry waste resources.***
- ***Provisions to encourage the implementation of demand-side management and energy efficiency programs.***

Amend the cost recovery procedures for electric power suppliers to provide for:

- ***Recovery of additional costs under the annual fuel charge.***
- ***Ongoing review of construction costs and the inclusion of construction costs in rates.***
- ***Recovery of construction costs for out-of-state electric generating facilities.***
- ***Recovery of project development costs for nuclear facilities.***
- ***Expanded recovery of construction work in progress under certain circumstances.***

Adjust the public utility and electric membership corporation regulatory fees.

Phase out the sales taxes paid by farmers and manufacturers for electricity, piped natural gas, and other fuels.

Establish renewable energy tax credits.

BILL ANALYSIS:

ESTABLISH RENEWABLE ENERGY AND ENERGY EFFICIENCY PORTFOLIO STANDARD.

Renewable Energy Portfolio Standards (REPS) require that utilities operating within a state provide a designated amount or percentage of power from renewable energy resources as a portion of their overall provision of electricity. Iowa enacted the first REPS in 1991 and as of June 2007, REPS have been enacted by the majority of the 24 states and the District of Columbia that have adopted standards requiring electric utilities to generate electricity from renewable resources. Over half of the American public lives in a state in which a REPS is in effect. The map at the end of this analysis identifies those states that have adopted standards for renewable energy generation.

States have adopted or expanded their REPS for many reasons including: economic development benefits through the promotion of a state's renewable energy resources; potential for jobs creation; prospect of increased reliability in electricity supply; and reduction of conventional air pollutants and greenhouse gases.

(From: *Race to the Top: The Expanding Role of U.S. State Renewable Portfolio Standards*, http://www.pewclimate.org/docUploads/RPSReportFinal%2Epdf.)

Section 1 would provide that it is the policy of the State to promote the development of renewable energy and energy efficiency through the implementation of a Renewable Energy and Energy Efficiency Portfolio Standard (REPS) that will:

- Diversify the resources used to reliably meet the energy needs of consumers in the State.
- Provide greater energy security through the use of indigenous energy resources available within the State.
- Encourage private investment in renewable energy and energy efficiency.
- Provide improved air quality and other benefits to energy consumers and citizens of the State.

Section 2 defines "renewable energy resource" as a solar electric, solar thermal, wind, hydropower, geothermal, or ocean current or wave energy resource; a biomass resource, including agricultural waste, animal waste, wood waste, spent pulping liquors, combustible residues, combustible liquids, combustible gases, energy crops, or landfill methane; waste heat derived from a renewable energy resource and used to produce electricity or useful, measurable thermal energy at a retail electric customer's facility; or hydrogen derived from a renewable energy resource. "Renewable energy resource" does not include peat, a fossil fuel or nuclear energy resource.

Section 2 would establish a Renewable Energy and Energy Efficiency Portfolio Standard (REPS) in North Carolina as follows:

Electric Public Utilities

Each electric public utility in the State would have to meet the Renewable Energy and Energy Efficiency Portfolio Standard (REPS) according to the following schedule:

Calendar Year	REPS Requirement
2012	3% of 2011 North Carolina retail sales
2015	6% of 2014 North Carolina retail sales
2018	10% of 2017 North Carolina retail sales
2021 and thereafter	12.5% of 2020 North Carolina retail sales

An electric public utility could meet the REPS requirement by doing any one or more of the following:

- Generate electric power at a new renewable energy facility.
- Use a renewable energy resource to generate electric power at a generating facility.
- Reduce energy consumption through the implementation of an energy efficiency measure.
- Purchase electric power from a new renewable energy facility.
- Purchase renewable energy certificates derived from in-state or out-of-state new renewable energy facilities.
- Use electric power that is supplied by a new renewable energy facility or saved due to the implementation of an energy efficiency measure that exceeds the requirements of this section for any calendar year as a credit towards meeting the requirements of this section in the following calendar year or sell the associated renewable energy certificates.

Electric Membership Corporations and Municipalities

Each electric membership corporation and municipality that sells electric power to retail electric customers in the State would have to meet the Renewable Energy and Energy Efficiency Portfolio Standard (REPS) according to the following schedule:

Calendar Year	REPS Requirement
2012	3% of 2011 North Carolina retail sales
2015	6% of 2014 North Carolina retail sales
2018 and thereafter	10% of 2017 North Carolina retail sales

An electric membership corporation or municipality could meet the REPS requirement by doing any one or more of the following:

- Generate electric power at a new renewable energy facility.
- Reduce energy consumption through the implementation of an energy efficiency measure.
- Purchase electric power from a new renewable energy facility.
- Purchase renewable energy certificates derived from in-state or out-of-state new renewable energy facilities.
- Acquire all or part of its electric power from an electric power supplier who meets the requirements of this section.
- Use electric power that is supplied by a new renewable energy facility or saved due to the implementation of an energy efficiency measure that exceeds the requirements of this section for any calendar year as a credit towards meeting the requirements of this section in the following calendar year or sell the associated renewable energy certificates.

Use of Solar Energy Resources

For calendar year 2018 and each calendar year thereafter, at least two tenths of one percent (0.2%) of the total electric power in kilowatt-hours sold to retail electric customers in the State would have to be supplied by a combination of new solar electric facilities and new metered solar thermal energy facilities

that use solar hot water, solar absorption cooling, solar dehumidification, solar thermally driven refrigeration, or solar industrial process heat. Electric power suppliers would comply with these requirements according to the following schedule:

Calendar Year	Requirement for Solar Energy Resources
2010	0.02%
2012	0.07%
2015	0.14%
2018	0.20%

Use of Swine Waste Resources

For calendar year 2018 and each calendar year thereafter, at least two tenths of one percent (0.2%) of the total electric power in kilowatt-hours sold to retail electric customers in the State would have to be supplied by swine waste. Electric power suppliers would comply with these requirements according to the following schedule:

Calendar Year	Requirement for Swine Waste Resources
2012	0.07%
2015	0.14%
2018	0.20%

Use of Poultry Waste Resources

For calendar year 2014 and each calendar year thereafter, at least nine hundred thousand (900,000) megawatt-hours of the total electric power sold to retail electric customers in the State would have to be supplied by poultry waste. Electric power suppliers would comply with these requirements according to the following schedule:

Calendar Year	Requirement for Poultry Waste Resources
2012	170,000 megawatt-hours
2013	700,000 megawatt-hours
2014	900,000 megawatt-hours

Control of Emissions

A biomass combustion process at any new renewable energy facility that delivers electric power to an electric power supplier would have to reduce emissions of air pollutants to the degree that is achievable for the facility, taking into account energy, environmental, and economic impacts and other costs.

Cost Cap

The recovery of costs that would be incurred by an electric power supplier to comply with the REPS requirements could not exceed an amount equal to the per-customer annual charges in the following schedule:

Customer Class	2008-2011	2012-2014	2015 and thereafter
Residential per account	$10.00	$12.00	$34.00
Commercial per account	$50.00	$150.00	$150.00
Industrial per account	$500.00	$1,000.00	$1,000.00

Adoption of Rules by the Utilities Commission

The Utilities Commission (Commission) would adopt rules to implement the REPS requirements that specifically:

- Provide for the monitoring of compliance with and enforcement of the REPS requirements.
- Include a procedure to modify or delay the REPS requirements in whole or in part if the Commission determines that it is in the public interest to do so and the public utility demonstrates that it has made a reasonable effort to meet the REPS requirements.
- Ensure that energy credited toward compliance with the provisions of this section not be credited toward any other purpose.
- Establish standards for interconnection of renewable energy facilities and other non-utility owned generation with a generation capacity of 10 megawatts or less to a public utility's electric distribution system.
- Ensure that the owner and operator of each renewable energy facility that delivers electric power to an electric power supplier is in substantial compliance with all federal and state laws, regulations, and rules for the protection of the environment and conservation of natural resources.
- Consider whether it is in the public interest to adopt rules for electric public utilities for net metering of renewable energy facilities with a generation capacity of one megawatt or less.
- Track and account for renewable energy certificates.

Reports, Evaluation, and Analysis

No later than October 1 of each year, beginning October 1, 2008, the Commission would submit a report on the activities taken by the Commission to implement and by electric power suppliers to comply with the REPS requirements to the Governor, the Environmental Review Commission, and the Joint Legislative Utility Review Committee.

The Commission would establish a procedure for evaluating renewable energy technologies; standards to ensure that renewable energy technologies do not harm the environment, natural resources, cultural resources, or public health, safety, or welfare of the State; and a permitting program to implement these protective standards.

No later than September 1 2008, the Commission would prepare and submit an analysis of whether rate structures, policies, and measures, including decoupling, in place in other states and countries that promote a mix of generation involving renewable energy sources and demand reduction should be implemented in North Carolina to the Governor, the Environmental Review Commission, and the Joint Legislative Utility Review Committee.

No later than October 1 of odd-numbered years, beginning October 1, 2009, the Commission would submit to the Governor, the Environmental Review Commission, and the Joint Legislative Utility Review Committee a report on the actual results of the costs allocation established by the act.

Section 3 would provide that if the federal government imposes requirements similar to the REPS requirements on electric power suppliers in the State, the Commission will determine the applicability of federal and State requirements so as to apply the more stringent requirements. The Commission would adopt rules to establish a procedure as an alternative to the procedure set out in G.S. 62-133 to annually adjust the rates of electric public utilities to allow timely recovery of all reasonable costs of compliance with the federal and State requirements. In adopting rules to establish the procedure, the Commission would incorporate the provisions of this act in accordance with this section and the public interest.

DEMAND-SIDE MANAGEMENT AND ENERGY EFFICIENCY MEASURES.

Section 2 defines "Demand-side management" as activities, programs, or initiatives undertaken by an electric power supplier or its customers to shift the timing of electricity use from peak to non peak demand periods. 'Demand side management' includes, but is not limited to, load management, electric system equipment and operating controls, direct load control, and interruptible load. This section defines "energy efficiency measure" as an equipment, physical, or program change implemented after 1 January 2007 that results in less energy used to perform the same function. 'Energy efficiency measure' includes, but is not limited to, energy produced from a combined heat and power system that uses non-renewable energy resources. 'Energy efficiency measure' does not include demand side management.

Section 4 would direct electric power suppliers to implement demand-side management and energy efficiency measures to establish the least cost mix of demand reduction and generation measures that meet the electricity needs of its customers. An electric power supplier may petition the Commission to approve an annual rider to its rates to recover all reasonable and prudent costs incurred for adoption and implementation of demand-side management and energy efficiency measures adopted and implemented after 1 January 2007. The Commission would assign the costs of measures only to the class of customers that directly benefit from the measures. No costs of demand-side management or energy efficiency programs would be assigned to an industrial customer that has or will implement its own demand-side management and energy efficiency measures. Recoverable costs would include, but not be limited to, all capital costs, including cost of capital and depreciation expenses, administrative costs, implementation costs, incentive payments to program participants, and operating costs.

AMEND COST RECOVERY PROCEDURES FOR ELECTRIC POWER SUPPLIERS.

Section 5: Recovery of Additional Costs under the Annual Fuel Charge.

Section 5 would shift the recovery of certain costs incurred by an electric public utility from recovery through the rate base to recovery through the annual fuel charge adjustment. The new costs that would be recoverable under this provision would be:

- The cost of ammonia, lime, limestone, urea, dibasic acid, sorbents, and catalysts consumed in reducing or treating emissions. These costs would be adjusted for gains or losses resulting from the sale of byproducts produced in the generation process.
- The total delivered non-capacity related costs, including all related transmission charges, of all purchases of electric power by the electric public utility.
- The capacity costs associated with purchases of electric power from qualifying cogeneration facilities and qualifying small power production facilities.
- Except for those costs recovered pursuant to the new REPS requirement statute, the total delivered costs of purchases of power from renewable energy facilities and new renewable energy facilities pursuant to the REPS requirement or any similar federal requirement.

- Cost recoverable under the fuel charge would be adjusted for gains or losses resulting from the sale of fuel, and other fuel related costs components.

For he total delivered non-capacity costs, the capacity costs associated with purchasing electric power from qualifying cogeneration and qualifying small power production facilities, and the costs of purchases of power from renewable energy facilities and new renewable energy facilities, the annual increase in the aggregate amount of these costs that are recoverable by an electric public utility could not exceed two percent (2%) of the electric public utility's total North Carolina retail jurisdictional gross revenues for the preceding calendar year. These costs would be recoverable from each class of customers as a separate component of the rider as follows:

- For the total delivered non-capacity costs, the specific component for each class of customers would be determined by allocating these costs among customer classes based on the electric public utility's North Carolina energy usage for the prior year, as determined by the Commission, until the Commission determines how these costs should be allocated in a general rate case for the electric public utility commenced on or after 1 January 2008.
- For the capacity costs associated with purchasing electric power from qualifying cogeneration and qualifying small power production facilities and the costs of purchases of power from renewable energy facilities and new renewable energy facilities, the specific component for each class of customers would be determined by allocating these costs among customer classes based on the electric public utility's North Carolina peak demand for the prior year, as determined by the Commission, until the Commission determines how these costs should be allocated in a general rate case for the electric public utility commenced on or after 1 January 2008.

Notwithstanding these provisions, cost recovery under the fuel charge would be modified for an electric public utility that has less than 150,000 North Carolina retail jurisdictional customers as of December 31, 2006.

Section 6: Ongoing Review of Construction Costs and Inclusion of Construction Costs in Rates.

Under current law, an electric public utility is responsible for bearing the construction costs of a generating facility until the facility goes into operation. In the first general rate case after the facility goes into service, if the Commission finds the facility to be used and useful, the total facility costs, excluding any imprudently incurred costs, are included in rates charged to customers. There is one exception to this system of construction cost recovery; prudently incurred expenses for construction work in progress may be included in the rate base if the Commission finds that this is in the public interest and is necessary to the utility's financial stability.

Under current practice, if a facility is abandoned before it is completed, the Commission may authorize the electric public utility to recover the costs of the incomplete facility, excluding any imprudently incurred costs, by amortizing these costs over a period of years, with no return on the unamortized balance.

Section 6 would alter these current procedures for construction cost recovery as follows.

A certificate for the construction of a coal or nuclear facility would be granted only if the applicant demonstrated and the Commission found that energy efficiency measures, demand side management, renewable energy resource generation, combined heat and power generation, or any combination of these, would not create a more cost effective and reliable generation system and that the construction and operation of such a facility is in the public interest.

Once a construction certificate has been granted by the Commission, a public utility may not cancel construction of a generating facility without receiving approval from the Commission. If the Commission finds that completion of the generating facility is no longer in the public interest, the Commission may modify or revoke the certificate.

A public utility would submit an annual progress report on construction to the Commission, including any revisions in the cost estimate for the construction. The Commission may conduct an ongoing review of construction of the facility. If the Commission disapproves any part of the revised cost estimate or finds that the incurrence of the cost of that portion of the construction of the facility then under review was unreasonable or imprudent, the Commission may modify or revoke the certificate.

The public utility would recover through rates in a general rate case the actual costs it has incurred in constructing a generating facility in reliance on a construction certificate as provided below, unless new evidence is discovered (i) that could not have been discovered by due diligence at an earlier time and (ii) that reasonably tends to show that a previous determination by the Commission that a material item of cost had been just and reasonable and prudently incurred was erroneous. The public utility would have the burden of proof to demonstrate that the material item of cost was in fact just and reasonable and prudently incurred.

Whether under construction or completed, if the construction of the facility:

- Has been subject to ongoing review, the reasonable and prudent costs of construction approved by the Commission during the ongoing review would be included in the public utility's rate base.
- Has not been subject to ongoing review, the costs of construction would be included in the public utility's rate base if the Commission finds that the incurrence of these costs is reasonable and prudent.

If the construction of a facility is cancelled and the facility:

- Has been subject to ongoing review, the public utility would recover through rates in a general rate case the costs of construction approved by the Commission during the ongoing review that were actually incurred prior to cancellation, amortized over a reasonable time as determined by the Commission. The public utility would have the burden of proof to demonstrate that the material item of cost was in fact just and reasonable and prudently incurred. In the general rate case, the Commission would make any adjustment that may be required.
- Has not been subject to ongoing review, the public utility would recover through rates in a general rate case the costs of construction that were actually incurred prior to cancellation and are found by the Commission to be reasonable and prudent, amortized over a reasonable time as determined by the Commission. In the general rate case, the Commission would make any adjustment that may be required.

Section 7: Recovery of Construction Costs for Out-of-State Electric Generating Facilities and Project Development Costs for Nuclear Facilities.

Section 7 would provide that upon petition by a public utility, the Commission would determine the need for and, if need is established, approve an estimate of the construction costs and construction schedule for an electric generating facility in another state. The construction cost estimate and the recovery of costs through a general rate case would be governed by the provision that apply to facilities built in the State (see Section 6 above).

Sections 7 would also provide for the treatment of project development costs for a nuclear facility as follows:

Section 7 defines "project development costs" as all capital costs associated with a potential nuclear electric generating facility, including the costs of evaluation, design, engineering, environmental analysis and permitting, early site permitting, combined operating license permitting, initial site preparation costs, and allowance for funds used during construction associated with such costs.

A public utility would be able to request that the Commission review the public utility's decision to incur project development costs for the construction of a nuclear electric generating facility. The Commission would approve the public utility's decision to incur project development costs if the public utility demonstrates by a preponderance of evidence that the decision to incur project development costs is reasonable and prudent.

All reasonable and prudent project development costs, as determined by the Commission, incurred for the potential nuclear electric generating facility would be included in the public utility's rate base and would be fully recoverable through rates in a general rate case If the public utility is allowed to cancel the project, the Commission would permit the public utility to recover all reasonable and prudently incurred project development costs in a general rate case amortized over a period equal to the period during which the costs were incurred, or five years, whichever is greater.

Section 8: Recovery of Construction Work in Progress.

Section 8 would change the standard by which the Commission may include construction work in progress included in rates. Under current law, construction work in progress may only be included if the Commission determines that inclusion is in the public interest and necessary to the financial stability of the utility. Section 8 would allow inclusion of construction work in progress if the construction is subject to ongoing review and Commission determines that expenditures are reasonable and prudent.

ADJUST THE PUBLIC UTILITY AND ELECTRIC MEMBERSHIP CORPORATION REGULATORY FEES.

Section 9 would provide that the percentage rate to be used in calculating the public utility regulatory fee under G.S. 62-302(b)(2) is twelve one-hundredths of one percent (0.12%) for each public utility's North Carolina jurisdictional revenues earned during each quarter that begins on or after July 1, 2007. This section also provides that the electric membership corporation regulatory fee imposed under G.S. 62-302(b1) for the 2007-2008 fiscal year is two hundred thousand dollars ($200,000).

PHASE OUT OF SALES TAXES PAID BY FARMERS AND MANUFACTURERS ON ELECTRICITY, PIPED NATURAL GAS, AND OTHER FUELS.

Sections 10, 11, and 12 would phase out the tax on electricity, piped natural gas, and fuel used by manufacturers to operate their industries and by farmers in their farming operations, effective for sales made on or after July 1, 2007

Section 10 would phase out the current sales tax rate of 2.83% on sales of electricity to manufacturing industries and manufacturing plants for use in connection with their operation and to farmers to be used by them for farming purposes as follows:

- Effective October 1, 2007, reduces the rate from 2.83% to 1.8%.
- Effective July 1, 2008, reduces the rate from 1.8% to 1.4%.
- Effective July 1, 2009, reduces the rate from 1.4% to 0.8%.

- Effective July 1, 2010, exempts these sales from tax.

The general rate of tax on sales of electricity is 3%. Sales of electricity to an aluminum smelting facility are taxed at the rate of 1%, but this rate expires for sales made on or after October 1, 2007. Last session, in S.L. 2006-66, the tax on sales of electricity to manufacturing industries and manufacturing plants was reduced from 2.83% to 2.6%, effective July 1, 2007. This bill repeals the reduction enacted last session and replaces it with the 1.89% rate provided in this section of the bill.

Section 11 would phase out the tax imposed on piped natural gas received by a manufacturer for use in connection with the operation of the manufacturing facility and on piped natural gas received by a farmer to be used for any farming purpose, other than preparing food, heating dwellings, and other household purposes.

The excise tax on piped natural gas applies uniformly to all users. The tax rate is structured as a "declining block" that decreases as the amount of therms of piped gas consumed in a month increases. A declining block tax rate structure means that low end users, such as residential users, pay a higher effective rate of tax and high volume users, such as business and industrial users, pay a lower effective rate of tax.

Section 12 would phase out the privilege tax imposed on a manufacturing industry or plant that purchases fuel to operate the industry or plant by reducing the tax rate from 1% to 0.7%, effective October 1, 2007, from 0.7% to 0.5%, effective July 1, 2008, from 0.5% to 0.3%, effective July 1, 2009, and from 0.3% to 0%, effective July 1, 2010.

Farmers are exempt from sales tax on purchases of fuel. Manufacturers are exempt from sales tax on fuel, but they are subject to a privilege tax equal to 1% of the sales price of the fuel. This section would phase that tax out over four years.

ESTABLISH RENEWABLE ENERGY TAX CREDITS.

Section 13

G.S. 105-129.16A provides a tax credit for investing in renewable energy property. This tax credit is not used by a nonprofit corporation that invests in renewable energy property because the nonprofit organization does not owe any tax. Section 13 would allow this tax credit to a taxpayer that makes an eligible contribution to a nonprofit organization organized under section 501(c)(3) of the Code. An eligible contribution is a contribution designated by the taxpayer to be used for investing in renewable energy property and used by the nonprofit organization for investing in renewable energy property.

The amount of the credit would be equal to a portion of the credit for investing in renewable energy property that the nonprofit organization would be allowed if the nonprofit organization was subject to tax. The amount of the credit for investing in renewable energy property is 35% of the cost of the property placed in service. The portion allowed to each taxpayer is equal to the percentage of the total costs for which the nonprofit organization would have been eligible for a credit which were covered by the taxpayer's eligible contribution.

The tax credit may be taken against either the franchise tax or the individual or corporate income tax. The election is binding and any carryforwards of a credit must be claimed against the same tax. The credit may not exceed 50% of the tax against which it is claimed. The credit is effective for taxable years beginning on or after January 1, 2007. Although this credit does not have a sunset, the credit under G.S. 105-129.16A expires for renewable energy property placed into service on or after January 1, 2011.

Renewable energy property includes the following machinery and equipment or real property:

- Biomass equipment that uses renewable biomass resources for biofuel production of ethanol, methanol, and biodiesel; anaerobic biogas production of methane utilizing agricultural and animal waste or garbage; or commercial thermal or electrical generation from renewable energy crops or wood waste materials. Renewable biomass resources are organic matters produced by terrestrial and aquatic plants and animals, such as standing vegetation, forestry and agricultural residues, landfill wastes, and animal wastes.
- Hydroelectric generators
- Solar energy equipment
- Wind equipment

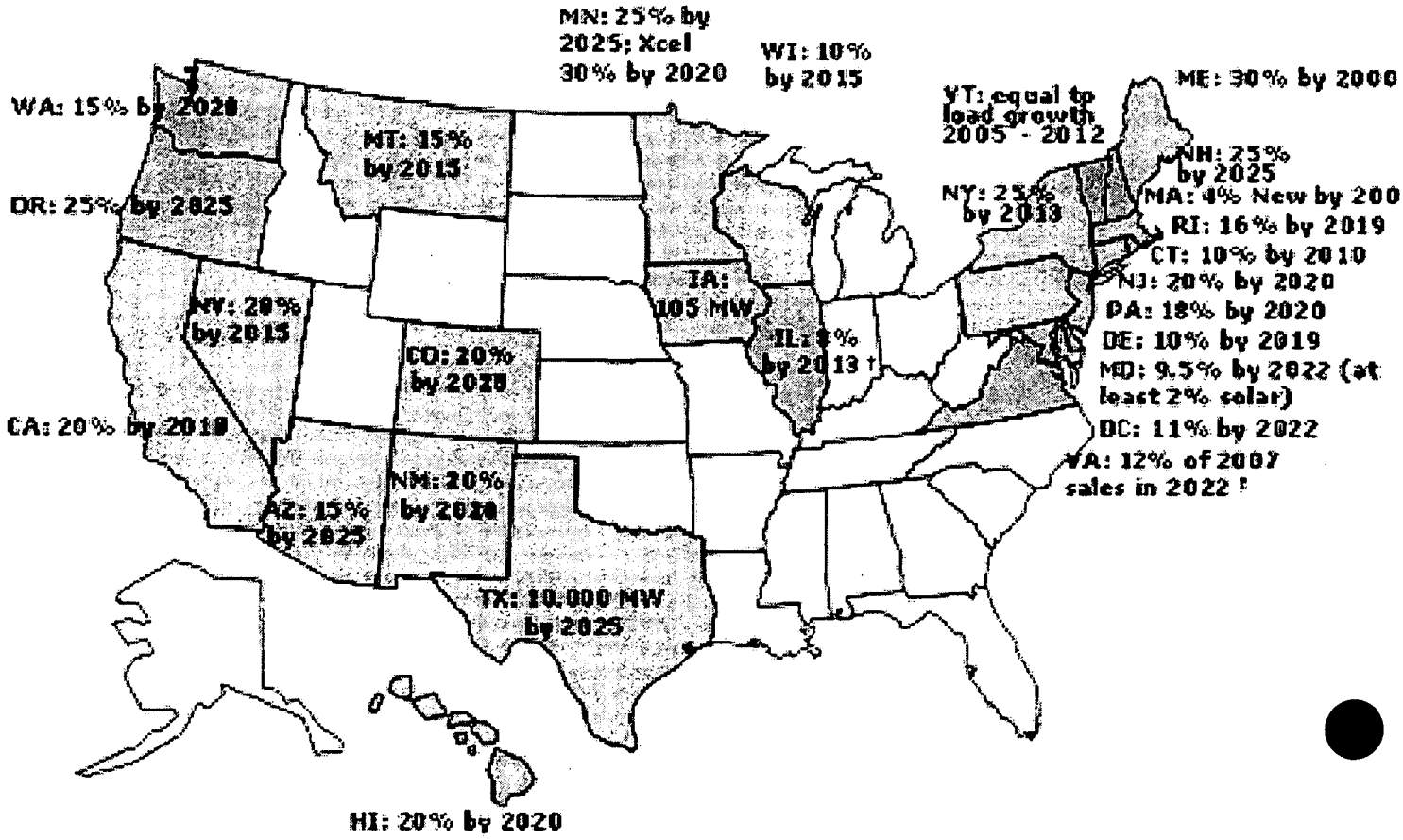
SEVERABILITY CLAUSE AND EFFECTIVE DATES.

Section 15 would provide that if any section or provision of the act is declared unconstitutional or invalid by the courts, the unconstitutional or invalid section or provision does not affect the validity of the act as a whole or any part of the act other than the unconstitutional or invalid part.

Section 16 would provide for the effective dates of the act as follows:

- Sections 1, 2, 6, 7, and 8 of the act would become effective 1 January 2008. The provisions of Section 2 of the act that provide for the recovery of costs incurred under Section 2 apply only to costs that are incurred on and after 1 January 2008.
- Sections 3, 4, 15, and 16 of the act would become effective when the act becomes law. The provisions of Section 4 of the act that provide for the recovery of costs incurred under Section 4 apply only to costs that are incurred on and after the date that the act becomes law.
- Section 5 of the act would become effective 1 January 2008 provided that (i) the provisions of G.S. 62-133.2, as amended by Section 5 of the act, apply only to fuel and fuel related costs incurred on and after 1 January 2008 regardless of the test period established by the Utilities Commission, and (ii) the costs described in G.S. 62-133.2(a1)(3) that are incurred on and after the date the act becomes law will be recoverable as provided in G.S. 62-133.2, as amended by Section 5 of the act.
- Sections 10, 11, 12, 13, and 14 of the act would become effective as provided in those sections.
- Section 9 of the act would become effective 1 July 2007.

States with Renewable Energy Portfolio Standards as of June 2007



†IL and VA RPS implemented through voluntary utility commitments

The percentages shown on the map for each state are not directly comparable to one another because each states' standard varies in its regulatory design with respect to: the definition of qualifying renewable energy resources; provisions for energy efficiency measures and applicability of renewable energy credit trading mechanisms; mandatory versus voluntary commitments; compliance standards and timetables; and the predominant state goals underlying development and implementation of the standard.

(From: The Pew Center on Global Climate Change,
http://www.pewclimate.org/what_s_being_done/in_the_states/rps.cfm)

Cindy Avrette, Committee Counsel, Finance Committees; Jennifer Mundt, Legislative Analyst for the Senate Committee on Agriculture, Environment, and Natural Resources; and Diana Jessup, Staff Attorney, North Carolina Utilities Commission - Public Staff, contributed to this summary.

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GENERAL ASSEMBLY OF NORTH CAROLINA
SESSION 2007

SESSION LAW 2007-397
SENATE BILL 3

AN ACT TO: (1) PROMOTE THE DEVELOPMENT OF RENEWABLE ENERGY AND ENERGY EFFICIENCY IN THE STATE THROUGH IMPLEMENTATION OF A RENEWABLE ENERGY AND ENERGY EFFICIENCY PORTFOLIO STANDARD (REPS), (2) ALLOW RECOVERY OF CERTAIN NONFUEL UTILITY COSTS THROUGH THE FUEL CHARGE ADJUSTMENT PROCEDURE, (3) PROVIDE FOR ONGOING REVIEW OF CONSTRUCTION COSTS AND FOR RECOVERY OF COSTS IN RATES IN A GENERAL RATE CASE, (4) ADJUST THE PUBLIC UTILITY AND ELECTRIC MEMBERSHIP CORPORATION REGULATORY FEES, (5) PROVIDE FOR THE PHASEOUT OF THE TAX ON THE SALE OF ENERGY TO NORTH CAROLINA FARMERS AND MANUFACTURERS, AND (6) ALLOW A TAX CREDIT TO CONTRIBUTORS TO 501(C)(3) ORGANIZATIONS FOR RENEWABLE ENERGY PROPERTY.

The General Assembly of North Carolina enacts:

SECTION 1. G.S. 62-2(a) reads as rewritten:

"**§ 62-2. Declaration of policy.**

(a) Upon investigation, it has been determined that the rates, services and operations of public utilities as defined herein, are affected with the public interest and that the availability of an adequate and reliable supply of electric power and natural gas to the people, economy and government of North Carolina is a matter of public policy. It is hereby declared to be the policy of the State of North Carolina:

...

(8) To cooperate with other states and with the federal government in promoting and coordinating interstate and intrastate public utility service and reliability of public utility energy supply; ~~and~~

(9) To facilitate the construction of facilities in and the extension of natural gas service to unserved areas in order to promote the public welfare throughout the State and to that end to authorize the creation of expansion funds for natural gas local distribution companies or gas districts to be administered under the supervision of the North Carolina Utilities ~~Commission.~~Commission; and

(10) To promote the development of renewable energy and energy efficiency through the implementation of a Renewable Energy and Energy Efficiency Portfolio Standard (REPS) that will do all of the following:

a. Diversify the resources used to reliably meet the energy needs of consumers in the State.

b. Provide greater energy security through the use of indigenous energy resources available within the State.

c. Encourage private investment in renewable energy and energy efficiency.

d. Provide improved air quality and other benefits to energy consumers and citizens of the State."

SECTION 2.(a) Article 7 of Chapter 62 of the General Statutes is amended by adding a new section to read:

"**§ 62-133.7. Renewable Energy and Energy Efficiency Portfolio Standard (REPS).**

(a) Definitions. – As used in this section:

(1) 'Combined heat and power system' means a system that uses waste heat to produce electricity or useful, measurable thermal or mechanical energy at a retail electric customer's facility.

(2) 'Demand-side management' means activities, programs, or initiatives undertaken by an electric power supplier or its customers to shift the timing of electricity use from peak to nonpeak demand periods. 'Demand-side management' includes, but is not limited to, load management, electric system equipment and operating controls, direct load control, and interruptible load.

(3) 'Electric power supplier' means a public utility, an electric membership corporation, or a municipality that sells electric power to retail electric power customers in the State.

(4) 'Energy efficiency measure' means an equipment, physical, or program change implemented after 1 January 2007 that results in less energy used to perform the same function. 'Energy efficiency measure' includes, but is not limited to, energy produced from a combined heat and power system that uses nonrenewable energy resources. 'Energy efficiency measure' does not include demand-side management.

(5) 'New renewable energy facility' means a renewable energy facility that either:

a. Was placed into service on or after 1 January 2007.

b. Delivers or has delivered electric power to an electric power supplier pursuant to a contract with NC GreenPower Corporation that was entered into prior to 1 January 2007.

c. Is a hydroelectric power facility with a generation capacity of 10 megawatts or less that delivers electric power to an electric power supplier.

(6) 'Renewable energy certificate' means a tradable instrument that is equal to one megawatt hour of electricity or equivalent energy supplied by a renewable energy facility, new renewable energy facility, or reduced by implementation of an energy efficiency measure that is used to track and verify compliance with the requirements of this section as determined by the Commission. A 'renewable energy certificate' does not include the related emission reductions, including, but not limited to, reductions of sulfur dioxide, oxides of nitrogen, mercury, or carbon dioxide.

(7) 'Renewable energy facility' means a facility, other than a hydroelectric power facility with a generation capacity of more than 10 megawatts, that either:

a. Generates electric power by the use of a renewable energy resource.

b. Generates useful, measurable combined heat and power derived from a renewable energy resource.

c. Is a solar thermal energy facility.

(8) 'Renewable energy resource' means a solar electric, solar thermal, wind, hydropower, geothermal, or ocean current or wave energy resource; a biomass resource, including agricultural waste, animal waste, wood waste, spent pulping liquors, combustible residues, combustible liquids, combustible gases, energy crops, or landfill methane; waste heat derived from a renewable energy resource and used to produce electricity or useful, measurable thermal energy at a

retail electric customer's facility; or hydrogen derived from a renewable energy resource. 'Renewable energy resource' does not include peat, a fossil fuel, or nuclear energy resource.

(b) Renewable Energy and Energy Efficiency Standards (REPS) for Electric Public Utilities. –

(1) Each electric public utility in the State shall be subject to a Renewable Energy and Energy Efficiency Portfolio Standard (REPS) according to the following schedule:

Calendar Year	REPS Requirement
2012	3% of 2011 North Carolina retail sales
2015	6% of 2014 North Carolina retail sales
2018	10% of 2017 North Carolina retail sales
2021 and thereafter	12.5% of 2020 North Carolina retail sales

(2) An electric public utility may meet the requirements of this section by any one or more of the following:

a. Generate electric power at a new renewable energy facility.

b. Use a renewable energy resource to generate electric power at a generating facility other than the generation of electric power from waste heat derived from the combustion of fossil fuel.

c. Reduce energy consumption through the implementation of an energy efficiency measure; provided, however, an electric public utility subject to the provisions of this subsection may meet up to twenty-five percent (25%) of the requirements of this section through savings due to implementation of energy efficiency measures. Beginning in calendar year 2021 and each year thereafter, an electric public utility may meet up to forty percent (40%) of the requirements of this section through savings due to implementation of energy efficiency measures.

d. Purchase electric power from a new renewable energy facility. Electric power purchased from a new renewable energy facility located outside the geographic boundaries of the State shall meet the requirements of this section if the electric power is delivered to a public utility that provides electric power to retail electric customers in the State; provided, however, the electric public utility shall not sell the renewable energy certificates created pursuant to this paragraph to another electric public utility.

e. Purchase renewable energy certificates derived from in-State or out-of-state new renewable energy facilities. Certificates derived from out-of-state new renewable energy facilities shall not be used to meet more than twenty-five percent (25%) of the requirements of this section, provided that this limitation shall not apply to an electric public utility with less than 150,000 North Carolina retail jurisdictional customers as of 31 December 2006.

f. Use electric power that is supplied by a new renewable energy facility or saved due to the implementation of an energy efficiency measure that exceeds the requirements of this section for any calendar year as a credit towards the requirements of this section in the following calendar year or sell the associated renewable energy certificates.

(c) Renewable Energy and Energy Efficiency Standards (REPS) for Electric Membership Corporations and Municipalities. –

(1) Each electric membership corporation or municipality that sells electric power to retail electric power customers in the State shall be

subject to a Renewable Energy and Energy Efficiency Portfolio Standard (REPS) according to the following schedule:

Calendar Year	REPS Requirement
2012	3% of 2011 North Carolina retail sales
2015	6% of 2014 North Carolina retail sales
2018 and thereafter	10% of 2017 North Carolina retail sales

(2) An electric membership corporation or municipality may meet the requirements of this section by any one or more of the following:

a. Generate electric power at a new renewable energy facility.

b. Reduce energy consumption through the implementation of demand-side management or energy efficiency measures.

c. Purchase electric power from a renewable energy facility or a hydroelectric power facility, provided that no more than thirty percent (30%) of the requirements of this section may be met with hydroelectric power, including allocations made by the Southeastern Power Administration.

d. Purchase renewable energy certificates derived from in-State or out-of-state renewable energy facilities. An electric power supplier subject to the requirements of this subsection may use certificates derived from out-of-state renewable energy facilities to meet no more than twenty-five percent (25%) of the requirements of this section.

e. Acquire all or part of its electric power through a wholesale purchase power agreement with a wholesale supplier of electric power whose portfolio of supply and demand options meets the requirements of this section.

f. Use electric power that is supplied by a new renewable energy facility or saved due to the implementation of demand-side management or energy efficiency measures that exceeds the requirements of this section for any calendar year as a credit towards the requirements of this section in the following calendar year or sell the associated renewable energy certificates.

(d) Compliance With REPS Requirement Through Use of Solar Energy Resources. – For calendar year 2018 and for each calendar year thereafter, at least two-tenths of one percent (0.2%) of the total electric power in kilowatt hours sold to retail electric customers in the State, or an equivalent amount of energy, shall be supplied by a combination of new solar electric facilities and new metered solar thermal energy facilities that use one or more of the following applications: solar hot water, solar absorption cooling, solar dehumidification, solar thermally driven refrigeration, and solar industrial process heat. The terms of any contract entered into between an electric power supplier and a new solar electric facility or new metered solar thermal energy facility shall be of sufficient length to stimulate development of solar energy; provided, the Commission shall develop a procedure to determine if an electric power supplier is in compliance with the provisions of this subsection if a new solar electric facility or a new metered solar thermal energy facility fails to meet the terms of its contract with the electric power supplier. As used in this subsection, 'new' means a facility that was first placed into service on or after 1 January 2007. The electric power suppliers shall comply with the requirements of this subsection according to the following schedule:

Calendar Year	Requirement for Solar Energy Resources
2010	0.02%
2012	0.07%
2015	0.14%
2018	0.20%

(e) Compliance With REPS Requirement Through Use of Swine Waste Resources. – For calendar year 2018 and for each calendar year thereafter, at least two-tenths of one percent (0.2%) of the total electric power in kilowatt hours sold to retail electric customers in the State shall be supplied, or contracted for supply in each year, by swine waste. The electric power suppliers, in the aggregate, shall comply with the requirements of this subsection according to the following schedule:

Calendar Year	Requirement for Swine Waste Resources
2012	0.07%
2015	0.14%
2018	0.20%

(f) Compliance With REPS Requirement Through Use of Poultry Waste Resources. – For calendar year 2014 and for each calendar year thereafter, at least 900,000 megawatt hours of the total electric power sold to retail electric customers in the State shall be supplied, or contracted for supply in each year, by poultry waste combined with wood shavings, straw, rice hulls, or other bedding material. The electric power suppliers, in the aggregate, shall comply with the requirements of this subsection according to the following schedule:

Calendar Year	Requirement for Poultry Waste Resources
2012	170,000 megawatt hours
2013	700,000 megawatt hours
2014	900,000 megawatt hours

(g) Control of Emissions. – As used in this subsection, Best Available Control Technology (BACT) means an emissions limitation based on the maximum degree a reduction in the emission of air pollutants that is achievable for a facility, taking into account energy, environmental, and economic impacts and other costs. A biomass combustion process at any new renewable energy facility that delivers electric power to an electric power supplier shall meet BACT. The Environmental Management Commission shall determine on a case-by-case basis the BACT for a facility that would not otherwise be required to comply with BACT pursuant to the Prevention of Significant Deterioration (PSD) emissions program. The Environmental Management Commission may adopt rules to implement this subsection. In adopting rules, the Environmental Management Commission shall take into account cumulative and secondary impacts associated with the concentration of biomass facilities in close proximity to one another. In adopting rules the Environmental Management Commission shall provide for the manner in which a facility that would not otherwise be required to comply with BACT pursuant to the PSD emissions programs shall meet the BACT requirement.

(h) Cost Recovery and Customer Charges. –

(1) For the purposes of this subsection, the term 'incremental costs' means all reasonable and prudent costs incurred by an electric power supplier to:

a. Comply with the requirements of subsections (b), (c), (d), (e), and (f) of this section that are in excess of the electric power supplier's avoided costs other than those costs recovered pursuant to G.S. 62-133.8.

b. Fund research that encourages the development of renewable energy, energy efficiency, or improved air quality, provided those costs do not exceed one million dollars ($1,000,000) per year.

c. Comply with any federal mandate that is similar to the requirements of subsections (b), (c), (d), (e), and (f) of this section that exceed the costs that the electric power supplier would have incurred under those subsections in the absence of the federal mandate.

(2) All reasonable and prudent costs incurred by an electric power supplier to comply with any federal mandate that is similar to the requirements of subsections (b), (c), (d), (e), and (f) of this section, including, but not limited to, the avoided costs associated with a federal mandate that exceeds the avoided costs that the electric power supplier would have incurred pursuant to subsections (b), (c), (d), (e), and (f) of this section in the absence of the federal mandate, shall be recovered by the electric power supplier in an annual rider charge assessed in accordance with the schedule set out in subdivision (4) of this subsection increased by the Commission on a pro rata basis to allow for full and complete recovery of all reasonable and prudent costs incurred to comply with the federal mandate.

(3) Except as provided in subdivision (2) of this subsection, the total annual incremental cost to be incurred by an electric power supplier and recovered from the electric power supplier's retail customers shall not exceed an amount equal to the per-account annual charges set out in subdivision (4) of this subsection applied to the electric power supplier's total number of customer accounts determined as of 31 December of the previous calendar year. An electric power supplier shall be conclusively deemed to be in compliance with the requirements of subsections (b), (c), (d), (e), and (f) of this section if the electric power supplier's total annual incremental costs incurred equals an amount equal to the per-account annual charges set out in subdivision (4) of this subsection applied to the electric power supplier's total number of customer accounts determined as of 31 December of the previous calendar year. The total annual incremental cost recoverable by an electric power supplier from an individual customer shall not exceed the per-account charges set out in subdivision (4) of this subsection except as these charges may be adjusted in subdivision (2) of this subsection.

(4) An electric power supplier shall be allowed to recover the incremental costs incurred to comply with the requirements of subsections (b), (c), (d), (e), and (f) of this section and fund research as provided in subdivision (1) of this subsection through an annual rider not to exceed the following per-account annual charges:

Customer Class	2008-2011	2012-2014	2015 and thereafter
Residential per account	$10.00	$12.00	$34.00
Commercial per account	$50.00	$150.00	$150.00
Industrial per account	$500.00	$1,000.00	$1,000.00

(5) The Commission shall adopt rules to establish a procedure for the annual assessment of the per-account charges set out in this subsection to an electric public utility's customers to allow for timely recovery of all reasonable and prudent costs of compliance with the requirements of subsections (b), (c), (d), (e), and (f) of this section and to fund research as provided in subdivision (1) of this subsection. The Commission shall ensure that the costs to be recovered from individual customers on a per-account basis pursuant to subdivisions (2) and (3) of this subsection are in the same proportion as the per-account annual charges for each customer class set out in subdivision (4) of this subsection.

(i) Adoption of Rules. – The Commission shall adopt rules to implement the provisions of this section. In developing rules, the Commission shall:

(1) Provide for the monitoring of compliance with and enforcement of the requirements of this section.

(2) Include a procedure to modify or delay the provisions of subsections (b), (c), (d), (e), and (f) of this section in whole or in part if the Commission determines that it is in the public interest to do so. The procedure adopted pursuant to this subdivision shall include a requirement that the electric power supplier demonstrate that it made a reasonable effort to meet the requirements set out in this section.

(3) Ensure that energy credited toward compliance with the provisions of this section not be credited toward any other purpose, including another renewable energy portfolio standard or voluntary renewable energy purchase program in this State or any other state.

(4) Establish standards for interconnection of renewable energy facilities and other nonutility-owned generation with a generation capacity of 10 megawatts or less to an electric public utility's distribution system; provided, however, that the Commission shall adopt, if appropriate, federal interconnection standards.

(5) Ensure that the owner and operator of each renewable energy facility that delivers electric power to an electric power supplier is in substantial compliance with all federal and state laws, regulations, and rules for the protection of the environment and conservation of natural resources.

(6) Consider whether it is in the public interest to adopt rules for electric public utilities for net metering of renewable energy facilities with a generation capacity of one megawatt or less.

(7) Develop procedures to track and account for renewable energy certificates, including ownership of renewable energy certificates that are derived from a customer owned renewable energy facility as a result of any action by a customer of an electric power supplier that is independent of a program sponsored by the electric power supplier.

(j) Report. – No later than 1 October of each year, the Commission shall submit a report on the activities taken by the Commission to implement, and by electric power suppliers to comply with, the requirements of this section to the Governor, the Environmental Review Commission, and the Joint Legislative Utility Review Committee. The report shall include any public comments received regarding direct, secondary, and cumulative environmental impacts of the implementation of the requirements of this section. In developing the report, the Commission shall consult with the Department of Environment and Natural Resources."

SECTION 2.(b) The Commission shall submit the first report required by G.S. 62-133.7(j), as enacted by subsection (a) of this section, no later than 1 October 2008.

SECTION 2.(c) G.S. 143B-282(a) reads as rewritten:

"(a) There is hereby created the Environmental Management Commission of the Department of Environment and Natural Resources with the power and duty to promulgate rules to be followed in the protection, preservation, and enhancement of the water and air resources of the State.

...

(6) The Commission may establish a procedure for evaluating renewable energy technologies that are, or are proposed to be, employed as part of a renewable energy facility, as defined in G.S. 62-133.7; establish standards to ensure that renewable energy technologies do not harm the environment, natural resources, cultural resources, or public health, safety, or welfare of the State; and, to the extent that there is not an environmental regulatory program, establish an environmental regulatory program to implement these protective standards."

SECTION 3. If the federal government imposes requirements similar to those set out in G.S. 62-133.7 on electric power suppliers in the State, the Utilities Commission shall determine the applicability of federal and State requirements so as to apply the more stringent requirements except to the extent that State requirements may be specifically preempted by federal law. The Commission shall adopt rules to establish a procedure as an alternative to the procedure set out in G.S. 62-133 to annually adjust the rates of electric public utilities to allow timely recovery of all reasonable costs of compliance with the federal and State requirements pursuant to G.S. 62-133.7(h), as enacted by Section 2 of this act. In adopting rules to establish the procedure, the Commission shall incorporate the provisions of this act in accordance with this section and the public interest.

SECTION 4.(a) Article 7 of Chapter 62 of the General Statutes is amended by adding a new section to read:

"**§ 62-133.8. Cost recovery for demand-side management and energy efficiency measures.**

(a) The definitions set out in G.S. 62-133.7 apply to this section. As used in this section, 'new,' used in connection with demand-side management or energy efficiency measure, means a demand-side management or energy efficiency measure that is adopted and implemented on or after 1 January 2007, including subsequent changes and modifications.

(b) Each electric power supplier shall implement demand-side management and energy efficiency measures and use supply-side resources to establish the least cost mix of demand reduction and generation measures that meet the electricity needs of its customers. An electric membership corporation or municipality that qualifies as an electric power supplier may satisfy the requirements of this section through its purchases from a wholesale supplier of electric power that uses supply-side resources and demand-side management to meet all or a portion of the supply needs of its members and their retail customers, and that, by aggregating and promoting demand-side management and energy efficiency measures for its members, meets the requirements of this section.

(c) Each electric power supplier to which G.S. 62-110.1 applies shall include an assessment of demand-side management and energy efficiency in its resource plans submitted to the Commission and shall submit cost-effective demand-side management and energy efficiency options that require incentives to the Commission for approval.

(d) The Commission shall, upon petition of an electric public utility, approve an annual rider to the electric public utility's rates to recover all reasonable and prudent costs incurred for adoption and implementation of new demand-side management and new energy efficiency measures. Recoverable costs include, but are not limited to, all capital costs, including cost of capital and depreciation expenses, administrative costs, implementation costs, incentive payments to program participants, and operating costs. In determining the amount of any rider, the Commission:

(1) Shall allow electric public utilities to capitalize all or a portion of those costs to the extent that those costs are intended to produce future benefits.

(2) May approve other incentives to electric public utilities for adopting and implementing new demand-side management and energy efficiency measures. Allowable incentives may include:

a. Appropriate rewards based on the sharing of savings achieved by the demand-side management and energy efficiency measures.

b. Appropriate rewards based on capitalization of a percentage of avoided costs achieved by demand-side management and energy efficiency measures.

c. Any other incentives that the Commission determines to be appropriate.

(e) The Commission shall determine the appropriate assignment of costs of new demand-side management and energy efficiency measures for electric public utilities and shall assign the costs of the programs only to the class or classes of customers that directly benefit from the programs.

(f) None of the costs of new demand-side management or energy efficiency measures of an electric power supplier shall be assigned to any industrial customer that notifies the industrial customer's electric power supplier that, at the industrial customer's own expense, the industrial customer has implemented at any time in the past or, in accordance with stated, quantified goals for demand-side management and energy efficiency, will implement alternative demand-side management and energy efficiency measures and that the industrial customer elects not to participate in demand-side management or energy efficiency measures under this section. The electric power supplier that provides electric service to the industrial customer, an industrial customer that receives electric service from the electric power supplier, the Public Staff, or the Commission on its own motion, may initiate a complaint proceeding before the Commission to challenge the validity of the notification of nonparticipation. The procedures set forth in G.S. 62-73, 62-74, and 62-75 shall govern any such complaint. The provisions of this subsection shall also apply to commercial customers with significant annual usage at a threshold level to be established by the Commission.

(g) An electric public utility shall not charge an industrial or commercial customer for the costs of installing demand-side management equipment on the customer's premises if the customer provides, at the customer's expense, equivalent demand-side management equipment.

(h) The Commission shall adopt rules to implement this section.

(i) The Commission shall submit to the Governor and to the Joint Legislative Utility Review Committee a summary of the proceedings conducted pursuant to this section during the preceding two fiscal years on or before 1 September of odd-numbered years."

SECTION 4.(b) The Utilities Commission shall submit the first report required by G.S. 62-133.8(i), as enacted by subsection (a) of this section, no later than 1 September 2009.

SECTION 4.(c) The Utilities Commission shall prepare an analysis of whether rate structures, policies, and measures, including decoupling, in place in other states and countries that promote a mix of generation involving renewable energy sources and demand reduction should be implemented in this State. The Commission shall submit this analysis to the Governor, Environmental Review Commission, and the Joint Legislative Utility Review Committee no later than 1 September 2008.

SECTION 5. G.S. 62-133.2 reads as rewritten:

"**§ 62-133.2. Fuel and fuel-related charge adjustments for electric utilities.**

(a) The Commission ~~may allow~~shall permit an electric ~~utilities~~ public utility that generates electric power by fossil fuel or nuclear fuel to charge ~~a uniform~~an increment or decrement as a rider to ~~their~~ its rates for changes in the cost of fuel ~~and the fuel component of purchased power~~and fuel-related costs used in providing ~~their~~ its North Carolina customers with electricity from the cost of fuel ~~and the fuel component of purchased power established in their previous general rate case.~~and fuel-related costs established in the electric public utility's previous general rate case on the basis of cost per kilowatt hour.

(a1) As used in this section, 'cost of fuel and fuel-related costs' means all of the following:

(1) The cost of fuel burned.

(2) The cost of fuel transportation.

(3) The cost of ammonia, lime, limestone, urea, dibasic acid, sorbents, and catalysts consumed in reducing or treating emissions.

(4) The total delivered noncapacity related costs, including all related transmission charges, of all purchases of electric power by the electric

public utility, that are subject to economic dispatch or economic curtailment.

(5) The capacity costs associated with all purchases of electric power from qualifying cogeneration facilities and qualifying small power production facilities, as defined in 16 U.S.C. § 796, that are subject to economic dispatch by the electric public utility.

(6) Except for those costs recovered pursuant to G.S. 62-133.7(h), the total delivered costs of all purchases of power from renewable energy facilities and new renewable energy facilities pursuant to G.S. 62-133.7 or to comply with any federal mandate that is similar to the requirements of subsections (b), (c), (d), (e), and (f) of G.S. 62-133.7.

(7) The fuel cost component of other purchased power.

(8) Cost of fuel and fuel-related costs shall be adjusted for any net gains or losses resulting from any sales by the electric public utility of fuel and other fuel-related costs components.

(9) Cost of fuel and fuel-related costs shall be adjusted for any net gains or losses resulting from any sales by the electric public utility of by-products produced in the generation process to the extent the costs of the inputs leading to that by-product are costs of fuel or fuel-related costs.

(a2) For those costs identified in subdivisions (4), (5), and (6) of subsection (a1) of this section, the annual increase in the aggregate amount of these costs that are recoverable by an electric public utility pursuant to this section shall not exceed two percent (2%) of the electric public utility's total North Carolina retail jurisdictional gross revenues for the preceding calendar year. The costs described in subdivisions (4), (5), and (6) of subsection (a1) of this section shall be recoverable from each class of customers as a separate component of the rider as follows:

(1) For the costs described in subdivision (4) of subsection (a1) of this section, the specific component for each class of customers shall be determined by allocating these costs among customer classes based on the electric public utility's North Carolina energy usage for the prior year, as determined by the Commission, until the Commission determines how these costs shall be allocated in a general rate case for the electric public utility commenced on or after 1 January 2008.

(2). For the costs described in subdivisions (5) and (6) of subsection (a1) of this section, the specific component for each class of customers shall be determined by allocating these costs among customer classes based on the electric public utility's North Carolina peak demand for the prior year, as determined by the Commission, until the Commission determines how these costs shall be allocated in a general rate case for the electric public utility commenced on or after 1 January 2008.

(a3) Notwithstanding subsections (a1) and (a2) of this section, for an electric public utility that has fewer than 150,000 North Carolina retail jurisdictional customers as of 31 December 2006, the costs identified in subdivisions (1), (2), (6), and (7) of subsection (a1) of this section and the fuel cost component, as may be modified by the Commission, of electric power purchases identified in subdivision (4) of subsection (a1) of this section shall be recovered through the increment or decrement rider approved by the Commission pursuant to this section. For the costs identified in subdivision (6) of subsection (a1) of this section that are incurred on or after 1 January 2008, the annual increase in the amount of these costs shall not exceed one percent (1%) of the electric public utility's total North Carolina retail jurisdictional gross revenues for the preceding calendar year. These costs described in subdivision (6) of subsection (a1) of this section shall be recoverable from each class of customers as a separate component of the rider. For the costs described in subdivision (6) of subsection (a1) of this section, the specific

component for each class of customers shall be determined by allocating these costs among customer classes based on the electric public utility's North Carolina peak demand for the prior year, as determined by the Commission, until the Commission determines how these costs shall be allocated in a general rate case for the electric public utility commenced on or after 1 January 2008.

(b) ~~For each electric utility engaged in the generation and production of electric power by fossil or nuclear fuels, the~~The Commission shall ~~hold~~ conduct a hearing within 12 months of ~~the~~ each electric public utility's last general rate case order ~~and~~ to determine whether an increment or decrement rider is required to reflect actual changes in the cost of fuel ~~and the fuel cost component of purchased power~~and fuel-related costs over or under the cost of fuel and fuel-related costs on a kilowatt-hour basis in base rates established in the electric public utility's last preceding general rate case. Additional hearings shall be held on an annual basis but only one hearing for each ~~such~~ electric public utility may be held within 12 months of the last general rate case.

(c) Each electric public utility shall submit to the Commission for the hearing verified annualized information and data in such form and detail as the Commission may require, for an historic 12-month test period, relating to:

(1) ~~Purchased cost~~Cost of fuel and fuel-related costs used in each generating facility owned in whole or in part by the utility.
(2) Fuel procurement practices and fuel inventories for each facility.
(3) Burned cost of fuel used in each generating facility.
(4) Plant capacity factor for each generating facility.
(5) Plant availability factor for each generating plant.
(6) Generation mix by types of fuel used.
(7) Sources and fuel cost component of purchased power used.
(8) Recipients of and revenues received for power sales and times of power sales.
(9) Test period ~~kilowatt hour~~kilowatt-hour sales for the utility's total system and on the total system separated for North Carolina jurisdictional sales.
(10) Procurement practices and inventories for: fuel burned and for ammonia, lime, limestone, urea, dibasic acid, sorbents, and catalysts consumed in reducing or treating emissions.
(11) The cost incurred at each generating facility of fuel burned and of ammonia, lime, limestone, urea, dibasic acid, sorbents, and catalysts consumed in reducing or treating emissions.
(12) Any net gains or losses resulting from any sales by the electric public utility of fuel or other fuel-related costs components.
(13) Any net gains or losses resulting from any sales by the electric public utility of by-products produced in the generation process to the extent the costs of the inputs leading to that by-product are costs of fuel or fuel-related costs.

(d) The Commission shall provide for notice of a public hearing with reasonable and adequate time for investigation and for all intervenors to prepare for hearing. At the hearing the Commission shall receive evidence from the utility, the ~~public staff,~~Public Staff, and any intervenor desiring to submit evidence, and from the public generally. In reaching its decision, the Commission shall consider all evidence required under subsection (c) of this section as well as any and all other competent evidence that may assist the Commission in reaching its decision including changes in the ~~price of fuel consumed and changes in the price of the fuel in the fuel component of purchased power occurring within a reasonable time (as determined by the Commission) after the test period is closed.~~cost of fuel consumed and fuel-related costs that occur within a reasonable time, as determined by the Commission, after the test period is closed. The Commission shall incorporate in its ~~fuel~~ cost of fuel and fuel-related costs determination under this subsection the experienced over-recovery or under-recovery of reasonable

costs of fuel and fuel-related costs ~~expenses~~ prudently incurred during the test period, based upon the prudent standards set pursuant to subsection (d1) of this section, in fixing an increment or decrement rider. Upon request of the electric public utility, the Commission shall also incorporate in this determination the experienced over-recovery or under-recovery of costs of fuel and fuel-related costs through the date that is 30 calendar days prior to the date of the hearing, provided that the reasonableness and prudence of these costs shall be subject to review in the utility's next annual hearing pursuant to this section. The Commission shall use deferral accounting, and consecutive test periods, in complying with this subsection, and the over-recovery or under-recovery portion of the increment or decrement shall be reflected in rates for 12 months, notwithstanding any changes in the base fuel cost in a general rate case. The burden of proof as to the correctness and reasonableness of the charge and as to whether the cost of fuel ~~charges~~ and fuel-related costs were reasonably and prudently incurred shall be on the utility. The Commission shall allow only that portion, if any, of a requested cost of fuel and fuel-related costs adjustment that is based on adjusted and reasonable cost of fuel ~~expenses~~ and fuel-related costs prudently incurred under efficient management and economic operations. In evaluating whether cost of fuel ~~expenses~~ and fuel-related costs were reasonable and prudently incurred, the Commission shall apply the rule adopted pursuant to subsection ~~(d1).~~(d1) of this section. To the extent that the Commission determines that an increment or decrement to the rates of the utility due to changes in the cost of fuel and ~~the fuel cost component of purchased power~~fuel-related costs over or under base fuel costs established in the preceding general rate case is just and reasonable, the Commission shall order that the increment or decrement become effective for all sales of electricity and remain in effect until changed in a subsequent general rate case or annual proceeding under this section.

(d1) Within one year after ratification of this act, for the purposes of setting ~~fuel rates,~~cost of fuel and fuel-related costs rates, the Commission shall adopt a rule that establishes prudent standards and procedures with which it can appropriately measure management efficiency in minimizing ~~fuel~~ cost of fuel and fuel-related costs.

(e) If the Commission has not issued an order pursuant to this section within ~~120~~ 180 days of a utility's submission of annual data under subsection (c) of this section, the utility may place the requested cost of fuel and fuel-related costs adjustment into effect. If the change in rate is finally determined to be excessive, the utility shall make refund of any excess plus interest to its customers in a manner ordered by the Commission.

(f) Nothing in this section shall relieve the Commission from its duty to consider the reasonableness of ~~fuel expenses~~the cost of fuel and fuel-related costs in a general rate case and to set rates reflecting reasonable ~~fuel expenses~~cost of fuel and fuel-related costs pursuant to G.S. 62-133. Nothing in this section shall invalidate or preempt any condition adopted by the Commission and accepted by the utility in any proceeding that would limit the recovery of costs by any electric public utility under this section.

(g) ~~On July 1, 1993 and every two years thereafter,~~On 1 July of every odd-numbered year, the Utilities Commission shall provide a report to the Joint Legislative Utility Review Committee summarizing the ~~procedures~~ proceedings conducted pursuant to ~~G.S. 62-133.2~~this section during the preceding two years."

SECTION 6. G.S. 62-110.1 reads as rewritten:

"**§ 62-110.1. Certificate for construction of generating facility; analysis of long-range needs for expansion of ~~facilities.~~facilities; ongoing review of construction costs; inclusion of approved construction costs in rates.**

(a) Notwithstanding the proviso in G.S. 62-110, no public utility or other person shall begin the construction of any steam, water, or other facility for the generation of electricity to be directly or indirectly used for the furnishing of public utility service, even though the facility be for furnishing the service already being rendered, without first obtaining from the Commission a certificate that public convenience and necessity requires, or will require, such construction.

(b) For the purpose of subsections (a), (c), and (d) of this section, "public utility" shall include any electric membership corporation operating within this State, and the term "public utility service" shall include the service rendered by any such electric membership corporation.

(c) The Commission shall develop, publicize, and keep current an analysis of the long-range needs for expansion of facilities for the generation of electricity in North Carolina, including its estimate of the probable future growth of the use of electricity, the probable needed generating reserves, the extent, size, mix and general location of generating plants and arrangements for pooling power to the extent not regulated by the Federal ~~Power~~ Energy Regulatory Commission and other arrangements with other utilities and energy suppliers to achieve maximum efficiencies for the benefit of the people of North Carolina, and shall consider such analysis in acting upon any petition by any utility for construction. In developing such analysis, the Commission shall confer and consult with the public utilities in North Carolina, the utilities commissions or comparable agencies of neighboring states, the Federal ~~Power~~ Energy Regulatory Commission, the Southern Growth Policies Board, and other agencies having relevant information and may participate as it deems useful in any joint boards investigating generating plant sites or the probable need for future generating facilities. In addition to such reports as public utilities may be required by statute or rule of the Commission to file with the Commission, any such utility in North Carolina may submit to the Commission its proposals as to the future needs for electricity to serve the people of the State or the area served by such utility, and insofar as practicable, each such utility and the Attorney General may attend or be represented at any formal conference conducted by the Commission in developing a plan for the future requirements of electricity for North Carolina or this region. In the course of making the analysis and developing the plan, the Commission shall conduct one or more public hearings. Each year, the Commission shall submit to the Governor and to the appropriate committees of the General Assembly a report of its analysis and plan, the progress to date in carrying out such plan, and the program of the Commission for the ensuing year in connection with such plan.

(d) In acting upon any petition for the construction of any facility for the generation of electricity, the Commission shall take into account the applicant's arrangements with other electric utilities for interchange of power, pooling of plant, purchase of power and other methods for providing reliable, ~~efficient~~ efficient, and economical electric service.

(e) As a condition for receiving ~~such certificate~~ a certificate, the applicant shall file an estimate of construction costs in such detail as the Commission may require. The Commission shall hold a public hearing on each ~~such~~ application and no certificate shall be granted unless the Commission has approved the estimated construction costs and made a finding that ~~such~~ construction will be consistent with the Commission's plan for expansion of electric generating capacity. A certificate for the construction of a coal or nuclear facility shall be granted only if the applicant demonstrates and the Commission finds that energy efficiency measures; demand-side management; renewable energy resource generation; combined heat and power generation; or any combination thereof, would not establish or maintain a more cost-effective and reliable generation system and that the construction and operation of the facility is in the public interest. In making its determination, the Commission shall consider resource and fuel diversity and reasonably anticipated future operating costs. Once the Commission grants a certificate, no public utility shall cancel construction of a generating unit or facility without approval from the Commission based upon a finding that the construction is no longer in the public interest.

(e1) Upon the request of the public utility or upon its own motion, the Commission may review the certificate to determine whether changes in the probable future growth of the use of electricity indicate that the public convenience and necessity require modification or revocation of the certificate. If the Commission finds that

completion of the generating facility is no longer in the public interest, the Commission may modify or revoke the certificate.

(f) ~~The Commission shall maintain an ongoing review of such construction as it proceeds and the applicant shall submit each year during construction a progress report and any revisions in the cost estimates for the construction.~~ The public utility shall submit a progress report and any revision in the cost estimate for the construction approved under subsection (e) of this section during each year of construction. Upon the request of the public utility or upon its own motion, the Commission may conduct an ongoing review of construction of the facility as the construction proceeds. If the Commission approves any revised construction cost estimate and finds that incurrence of the cost of that portion of the construction of the facility under review was reasonable and prudent, the certificate shall remain in effect. If the Commission disapproves any part of the revised cost estimate or finds that the incurrence of the cost of that portion of the construction of the facility then under review was unreasonable or imprudent, the Commission may modify or revoke the certificate.

(f1) The public utility shall recover through rates in a general rate case conducted pursuant to G.S. 62-133 the actual costs it has incurred in constructing a generating facility in reliance on a certificate issued under this section as provided in this subsection, unless new evidence is discovered (i) that could not have been discovered by due diligence at an earlier time and (ii) that reasonably tends to show that a previous determination by the Commission that a material item of cost was just and reasonable and prudently incurred was erroneous. If the Commission determines that evidence has been submitted that meets the requirements of this subsection, the public utility shall have the burden of proof to demonstrate that the material item of cost was in fact just and reasonable and prudently incurred.

(1) When a facility has been completed, and the construction of the facility has been subject to ongoing review under subsection (f) of this section, the reasonable and prudent costs of construction approved by the Commission during the ongoing review shall be included in the public utility's rate base without further review by the Commission.

(2) If a facility has not been completed, and the construction of the facility has been subject to ongoing review under subsection (f) of this section, the reasonable and prudent costs of construction approved by the Commission during the ongoing review shall be included in the public utility's rate base without further review by the Commission.

(3) If a facility is under construction or has been completed and the construction of the facility has not been subject to ongoing review under subsection (f) of this section, the costs of construction shall be included in the public utility's rate base if the Commission finds that the incurrence of these costs is reasonable and prudent.

(f2) If the construction of a facility is cancelled, including cancellation as a result of modification or revocation of the certificate under subsection (e1) of this section, and the construction of the facility has been subject to ongoing review under subsection (f), absent newly discovered evidence (i) that could not have been discovered by due diligence at an earlier time and (ii) that reasonably tends to show that a previous determination by the Commission that a material item of cost was just and reasonable and prudently incurred was erroneous, the public utility shall recover through rates in a general rate case conducted pursuant to G.S. 62-133 the costs of construction approved by the Commission during the ongoing review that were actually incurred prior to cancellation, amortized over a reasonable time as determined by the Commission. In the general rate case, the Commission shall make any adjustment that may be required because costs of construction previously added to the utility's rate base pursuant to subsection (f1) of this section are removed from the rate base and recovered in accordance with this subsection. Any costs of construction actually incurred, but not previously approved by the Commission, shall be recovered only if they are found by

the Commission to be reasonable and prudent. If the Commission determines that evidence has been submitted that meets the requirements of this subsection, the public utility shall have the burden of proof to demonstrate that the material item of cost was just and reasonable and prudently incurred.

(f3) If the construction of a facility is cancelled, including cancellation as a result of the modification or revocation of the certificate under subsection (e1) of this section, and the construction of the facility has not been subject to ongoing review under subsection (f) of this section, the public utility shall recover through rates in a general rate case conducted pursuant to G.S. 62-133 the costs of construction that were actually incurred prior to the cancellation and are found by the Commission to be reasonable and prudent, amortized over a reasonable time as determined by the Commission. In the general rate case, the Commission shall make any adjustment that may be required because costs of construction previously added to the utility's rate base pursuant to subsection (f1) of this section are removed from the rate base and recovered in accordance with this subsection.

(g) The certification requirements of this section shall not apply to a nonutility-owned generating facility fueled by renewable energy resources under two megawatts in capacity or to persons who construct an electric generating facility primarily for that person's own use and not for the primary purpose of producing electricity, heat, or steam for sale to or for the public for compensation; provided, however, that such persons shall, nevertheless, be required to report to the Utilities Commission the proposed construction of such a facility before beginning construction thereof."

SECTION 7. Article 6 of Chapter 62 of the General Statutes is amended by adding two new sections to read:

"**§ 62-110.6. Rate recovery for construction costs of out-of-state electric generating facilities.**

(a) The Commission shall, upon petition of a public utility, determine the need for and, if need is established, approve an estimate of the construction costs and construction schedule for an electric generating facility in another state that is intended to serve retail customers in this State.

(b) The petition may be filed at any time after an application for a certificate or license for the construction of the facility has been filed in the state in which the facility will be sited. The petition shall contain a showing of need for the facility, an estimate of the construction costs, and the proposed construction schedule for the facility.

(c) The Commission shall conduct a public hearing to consider and determine the need for the facility and the reasonableness of the construction cost estimate and proposed construction schedule. If the Commission finds that the construction will be needed to assure the provision of adequate public utility service within North Carolina, the Commission shall approve a construction cost estimate and a construction schedule for the facility. In making its determinations under this section, the Commission may consider whether the state in which the facility will be sited has issued a certificate or license for construction of the facility and approved a construction cost estimate and construction schedule for the facility. The Commission shall issue its order not later than 180 days after the public utility files its petition.

(d) G.S. 62-110.1(f) shall apply to the construction cost estimate determined by the Commission to be appropriate, and the actual costs the public utility incurs in constructing the facility shall be recoverable through rates in a general rate case pursuant to G.S. 62-133 as provided in G.S. 62-110.1(f1).

(e) If the construction of a facility is cancelled, the public utility shall recover through rates in a general rate case conducted pursuant to G.S. 62-133 the costs of construction that were actually incurred prior to the cancellation and are found by the Commission to be reasonable and prudent, as provided in subsections (f2) and (f3) of G.S. 62-110.1.

"**§ 62-110.7. Project development cost review for a nuclear facility.**

(a) For purposes of this section, "project development costs" mean all capital costs associated with a potential nuclear electric generating facility incurred before (i) issuance of a certificate under G.S. 62-110.1 for a facility located in North Carolina or (ii) issuance of a certificate by the host state for an out-of-state facility to serve North Carolina retail customers, including, without limitation, the costs of evaluation, design, engineering, environmental analysis and permitting, early site permitting, combined operating license permitting, initial site preparation costs, and allowance for funds used during construction associated with such costs.

(b) At any time prior to the filing of an application for a certificate to construct a potential nuclear electric generating facility, either under G.S. 62-110.1 or in another state for a facility to serve North Carolina retail customers, a public utility may request that the Commission review the public utility's decision to incur project development costs. The public utility shall include with its request such information and documentation as is necessary to support approval of the decision to incur proposed project development costs. The Commission shall hold a hearing regarding the request. The Commission shall issue an order within 180 days after the public utility files its request. The Commission shall approve the public utility's decision to incur project development costs if the public utility demonstrates by a preponderance of evidence that the decision to incur project development costs is reasonable and prudent; provided, however, the Commission shall not rule on the reasonableness or prudence of specific project development activities or recoverability of specific items of cost.

(c) All reasonable and prudent project development costs, as determined by the Commission, incurred for the potential nuclear electric generating facility shall be included in the public utility's rate base and shall be fully recoverable through rates in a general rate case proceeding pursuant to G.S. 62-133.

(d) If the public utility is allowed to cancel the project, the Commission shall permit the public utility to recover all reasonable and prudently incurred project development costs in a general rate case proceeding pursuant to G.S. 62-133 amortized over a period equal to the period during which the costs were incurred, or five years, whichever is greater."

SECTION 8. G.S. 62-133(b) reads as rewritten:

"(b) In fixing such rates, the Commission shall:

(1) Ascertain the reasonable original cost of the public utility's property used and useful, or to be used and useful within a reasonable time after the test period, in providing the service rendered to the public within the State, less that portion of the cost ~~which~~ that has been consumed by previous use recovered by depreciation ~~expense plus the reasonable original cost of investment in plant under construction (construction work in progress). In ascertaining the cost of the public utility's property, construction work in progress as of the effective date of this subsection shall be excluded until such plant comes into service but reasonable and prudent expenditures for construction work in progress after the effective date of this subsection may be included, to the extent the Commission considers such inclusion in the public interest and necessary to the financial stability of the utility in question, subject to the provisions of subparagraph (b)(4a) of this section.~~expense. In addition, construction work in progress may be included in the cost of the public utility's property under any of the following circumstances:

a. To the extent the Commission considers inclusion in the public interest and necessary to the financial stability of the utility in question, reasonable and prudent expenditures for construction work in progress may be included, subject to the provisions of subdivision (4a) of this subsection.

b. For baseload electric generating facilities, reasonable and prudent expenditures shall be included pursuant to subdivisions

(2) or (3) of G.S. 62-110.1(f1), whichever applies, subject to the provisions of subdivision (4a) of this subsection.

(1a) Apply the rate of return established under subdivision (4) of this subsection to rights-of-way acquired through agreements with the Department of Transportation pursuant to G.S. 136-19.5(a) if acquisition is consistent with a definite plan to provide service within five years of the date of the agreement and if such right-of-way acquisition will result in benefits to the ratepayers. If a right-of-way is not used within a reasonable time after the expiration of the five-year period, it may be removed from the rate base by the Commission when rates for the public utility are next established under this section.

(2) Estimate such public utility's revenue under the present and proposed rates.

(3) Ascertain such public utility's reasonable operating expenses, including actual investment currently consumed through reasonable actual depreciation.

(4) Fix such rate of return on the cost of the property ascertained pursuant to subdivision (1) of this subsection as will enable the public utility by sound management to produce a fair return for its shareholders, considering changing economic conditions and other factors, including, but not limited to, the inclusion of construction work in progress in the utility's property under sub-subdivision b. of subdivision (1) of this subsection, as they then exist, to maintain its facilities and services in accordance with the reasonable requirements of its customers in the territory covered by its franchise, and to compete in the market for capital funds on terms ~~which~~ that are reasonable and ~~which~~ that are fair to its customers and to its existing investors.

(4a) Require each public utility to discontinue capitalization of the composite carrying cost of capital funds used to finance construction (allowance for funds) on the construction work in progress included in its rate based upon the effective date of the first and each subsequent general rate order issued with respect to it after the effective date of this subsection; allowance for funds may be capitalized with respect to expenditures for construction work in progress not included in the utility's property upon which the rates were fixed. In determining net operating income for return, the Commission shall not include any capitalized allowance for funds used during construction on the construction work in progress included in the utility's rate base.

(5) Fix such rates to be charged by the public utility as will earn in addition to reasonable operating expenses ascertained pursuant to subdivision (3) of this subsection the rate of return fixed pursuant to subdivisions (4) and (4a) on the cost of the public utility's property ascertained pursuant to subdivisions (1) and (1a) of this subsection."

SECTION 9.(a) The percentage rate to be used in calculating the public utility regulatory fee under G.S. 62-302(b)(2) is twelve one-hundredths of one percent (0.12%) for each public utility's North Carolina jurisdictional revenues earned during each quarter that begins on or after 1 July 2007.

SECTION 9.(b) The electric membership corporation regulatory fee imposed under G.S. 62-302(b1) for the 2007-2008 fiscal year is two hundred thousand dollars ($200,000).

SECTION 10.(a) G.S. 105-164.4(a)(1i) is repealed.

SECTION 10.(b) G.S. 105-164.4(a)(1f) reads as rewritten:

"(a) A privilege tax is imposed on a retailer at the following percentage rates of the retailer's net taxable sales or gross receipts, as appropriate. The general rate of tax is four and one-quarter percent (4.25%).

...

(1f) The rate of two and eighty-three-hundredths percent (2.83%) applies to the sales price of electricity ~~described in this subdivision and~~ that is measured by a separate meter or another separate ~~device:~~device and sold to a commercial laundry or to a pressing and dry-cleaning establishment for use in machinery used in the direct performance of the laundering or the pressing and cleaning service.

~~a. Sales of electricity to farmers to be used by them for any farm purposes other than preparing food, heating dwellings, and other household purposes. The quantity of electricity or gas purchased or used at any one time shall not be a determinative factor as to whether its sale or use is or is not subject to the rate of tax provided in this subdivision.~~

b. Repealed.

~~c. Sales of electricity to commercial laundries or to pressing and dry-cleaning establishments for use in machinery used in the direct performance of the laundering or the pressing and cleaning service.~~"

SECTION 10.(c) G.S. 105-164.4(a) is amended by adding a new subdivision to read:

"(a) A privilege tax is imposed on a retailer at the following percentage rates of the retailer's net taxable sales or gross receipts, as appropriate. The general rate of tax is four and one-quarter percent (4.25%).

...

(1j) The rate of one and eight-tenths percent (1.8%) applies to the sales price of electricity described in this subdivision and measured by a separate meter or another separate device:

a. Sales of electricity to manufacturing industries and manufacturing plants for use in connection with the operation of the industries and plants.

b. Sales of electricity to farmers to be used by them for any farming purposes other than preparing food, heating dwellings, and other household purposes."

SECTION 10.(d) G.S. 105-164.4(a)(1j), as enacted by subsection (c) of this section, reads as rewritten:

"(1j) The rate of ~~one and eight-tenths percent (1.8%)~~ one and four-tenths percent (1.4%) applies to the sales price of electricity described in this subdivision and measured by a separate meter or another separate device:

a. Sales of electricity to manufacturing industries and manufacturing plants for use in connection with the operation of the industries and plants.

b. Sales of electricity to farmers to be used by them for any farming purposes other than preparing food, heating dwellings, and other household purposes."

SECTION 10.(e) G.S. 105-164.4(a)(1j), as enacted by subsection (c) of this section and amended by subsection (d) of this section, reads as rewritten:

"(1j) The rate of ~~one and four-tenths percent (1.4%)~~ eight-tenths percent (0.8%) applies to the sales price of electricity described in this subdivision and measured by a separate meter or another separate device:

a. Sales of electricity to manufacturing industries and manufacturing plants for use in connection with the operation of the industries and plants.

b. Sales of electricity to farmers to be used by them for any farming purposes other than preparing food, heating dwellings, and other household purposes."

SECTION 10.(f) G.S. 105-164.4(a)(1j), as enacted by this section, is repealed.

SECTION 10.(g) G.S. 105-164.13(1) reads as rewritten:

"**§ 105-164.13. Retail sales and use tax.**

The sale at retail and the use, storage, or consumption in this State of the following tangible personal property and services are specifically exempted from the tax imposed by this Article:

Agricultural Group.

(1) Any of the following items sold to a farmer for use by the farmer in the planting, cultivating, harvesting, or curing of farm crops or in the production of dairy products, eggs, or animals. A "farmer" includes a dairy operator, a poultry farmer, an egg producer, a livestock farmer, a farmer of crops, and a farmer of an aquatic species, as defined in G.S. 106-758.

a. Commercial fertilizer, lime, land plaster, plastic mulch, plant bed covers, potting soil, and seeds.

b. Farm machinery, attachment and repair parts for farm machinery, and lubricants applied to farm machinery. The term "machinery" includes implements that have moving parts or are operated or drawn by an animal. The term does not include implements operated wholly by hand or motor vehicles required to be registered under Chapter 20 of the General Statutes.

c. A horse or mule.

d. ~~Fuel other than electricity.~~Fuel."

SECTION 10.(h) G.S. 105-164.13 is amended by adding two new subdivisions to read:

"**§ 105-164.13. Retail sales and use tax.**

The sale at retail and the use, storage, or consumption in this State of the following tangible personal property and services are specifically exempted from the tax imposed by this Article:

...

(1b) Electricity sold to a farmer to be used for any farming purpose other than preparing food, heating dwellings, and other household purposes.

...

(56) Fuel and electricity sold to a manufacturer for use in connection with the operation of a manufacturing facility."

SECTION 10.(i) Subsections (a), (b), and (c) of this section become effective 1 October 2007 and apply to sales occurring on or after that date. Subsection (d) of this section becomes effective 1 July 2008 and applies to sales occurring on or after that date. Subsection (e) of this section becomes effective 1 July 2009 and applies to sales occurring on or after that date. Subsections (f), (g), and (h) of this section become effective 1 July 2010 and apply to sales occurring on or after that date. The remainder of this section is effective when it becomes law.

SECTION 11.(a) G.S. 105-187.41 reads as rewritten:

"**§ 105-187.41. Tax imposed on piped natural gas.**

(a) Scope. – An excise tax is imposed on piped natural gas received for consumption in this State. This tax is imposed in lieu of a sales and use tax and a percentage gross receipts tax on piped natural gas.

(b) Rate. – The tax rate is set in the table below. The tax rate is based on monthly therm volumes of piped natural gas received by the end-user of the gas. If an end-user receives piped natural gas that is metered through two or more separate measuring devices, the tax is calculated separately on the volume metered through each device rather than on the total volume metered through all measuring devices, unless the devices are located on the same premises and are part of the same billing account. In that circumstance, the tax is calculated on the total volume metered through the two or more separate measuring devices.

Monthly Volume of Therms Received	Rate Per Therm
First 200	$.047
201 to 15,000	.035
15,001 to 60,000	.024
60,001 to 500,000	.015
Over 500,000	.003

(c) Gas City Exemption. – The tax imposed by this section does not apply to piped natural gas received by a gas city for consumption by that city or to piped natural gas delivered by a gas city to a sales or transportation customer of the gas city.

(d) Reduced Rate. – Piped natural gas received by a manufacturer for use in connection with the operation of a manufacturing facility or by a farmer to be used for any farming purpose other than preparing food, heating dwellings, and other household purposes is taxable at a reduced rate as provided in this subsection. To be eligible for the reduced tax rate, a person must have a manufacturer's certificate or a farmer's certificate issued under G.S. 105-164.28A. A person who uses piped natural gas for an unauthorized purpose is liable for any tax due on the gas.

Monthly Volume of Therms Received	Rate Per Therm
First 200	$.032
201 to 15,000	.024
15,001 to 60,000	.016
60,001 to 500,000	.010
Over 500,000	.002"

SECTION 11.(b) G.S. 105-187.41(d), as enacted by subsection (a) of this section, reads as rewritten:

"(d) Reduced Rate. – Piped natural gas received by a manufacturer for use in connection with the operation of a manufacturing facility and by a farmer to be used for any farming purpose other than preparing food, heating dwellings, and other household purposes is taxable as provided in this subsection. To be eligible for the reduced tax rate, a person must have a manufacturer's certificate or a farmer's certificate issued under G.S. 105-164.28A. A person who uses piped natural gas for an unauthorized purpose is liable for any tax due on the gas.

Monthly Volume of Therms Received	Rate Per Therm
First 200	~~$.032~~.025
201 to 15,000	~~.024~~.019
15,001 to 60,000	~~.016~~.013
60,001 to 500,000	~~.010~~.008
Over 500,000	~~.002~~.002"

SECTION 11.(c) G.S. 105-187.41(d), as enacted by subsection (a) of this section and amended by subsection (b) of this section, reads as rewritten:

"(d) Reduced Rate. – Piped natural gas received by a manufacturer for use in connection with the operation of a manufacturing facility and by a farmer to be used for

any farming purpose other than preparing food, heating dwellings, and other household purposes is taxable as provided in this subsection. To be eligible for the reduced tax rate, a person must have a manufacturer's certificate or a farmer's certificate issued under G.S. 105-164.28A. A person who uses piped natural gas for an unauthorized purpose is liable for any tax due on the gas.

Monthly Volume of Therms Received	Rate Per Therm
First 200	$~~.025~~.014
201 to 15,000	~~.019~~.010
15,001 to 60,000	~~.013~~.007
60,001 to 500,000	~~.008~~.004
Over 500,000	~~.002~~.001"

SECTION 11.(d) G.S. 105-187.41(d), as enacted by this section, is repealed.

SECTION 11.(e) G.S. 105-187.41(c) reads as rewritten:

"(c) ~~Gas City Exemption.~~ Exemptions. – The tax imposed by this section does not apply to ~~piped~~ any of the following:

(1) Piped natural gas received by a gas city for consumption by that ~~city or to piped~~ city.

(2) Piped natural gas delivered by a gas city to a sales or transportation customer of the gas city.

(3) Piped natural gas received by a manufacturer for use in connection with the operation of the manufacturing facility. To be eligible for the exemption, a person must have a manufacturer's certificate issued under G.S. 105-164.28A. A person who uses piped natural gas for an unauthorized purpose is liable for any tax due on the gas.

(4) Piped natural gas received by a farmer to be used for any farming purpose other than preparing food, heating dwellings, and other household purposes. To be eligible for the exemption, a person must have a farmer's certificate issued under G.S. 105-164.28A. A person who uses piped natural gas for an unauthorized purpose is liable for any tax due on the gas."

SECTION 11.(f) Subsection (a) of this section becomes effective 1 October 2007 and applies to bills issued on or after that date. Subsection (b) of this section becomes effective 1 July 2008 and applies to bills issued on or after that date. Subsection (c) of this section becomes effective 1 July 2009 and applies to bills issued on or after that date. Subsections (d) and (e) of this section become effective 1 July 2010 and apply to bills issued on or after that date. The remainder of this section is effective when it becomes law.

SECTION 12.(a) G.S. 105-187.51A reads as rewritten:

"**§ 105-187.51A. Tax imposed on manufacturing fuel.**

A privilege tax is imposed on a manufacturing industry or plant that purchases fuel to operate the industry or plant. The tax is ~~one percent (1%)~~ seven-tenths percent (0.7%) of the sales price of the fuel. The tax does not apply to electricity or piped natural gas."

SECTION 12.(b) G.S. 105-187.51A, as amended by subsection (a) of this section, reads as rewritten:

"**§ 105-187.51A. Tax imposed on manufacturing fuel.**

A privilege tax is imposed on a manufacturing industry or plant that purchases fuel to operate the industry or plant. The tax is ~~seven-tenths percent~~ five-tenths percent (0.5%) of the sales price of the fuel. The tax does not apply to electricity or piped natural gas."

SECTION 12.(c) G.S. 105-187.51A, as amended by subsection (a) of this section, reads as rewritten:

"**§ 105-187.51A. Tax imposed on manufacturing fuel.**

A privilege tax is imposed on a manufacturing industry or plant that purchases fuel to operate the industry or plant. The tax is ~~five-tenths percent (0.5%)~~ three-tenths

percent (0.3%) of the sales price of the fuel. The tax does not apply to electricity or piped natural gas."

SECTION 12.(d) G.S. 105-187.51A is repealed.

SECTION 12.(e) Subsection (a) of this section becomes effective 1 October 2007 and applies to fuel purchased on or after that date. Subsection (b) of this section becomes effective 1 July 2008 and applies to fuel purchased on or after that date. Subsection (c) of this section becomes effective 1 July 2009 and applies to fuel purchased on or after that date. Subsection (d) of this section becomes effective 1 July 2010. The remainder of this section is effective when it becomes law.

SECTION 13.(a) Article 3B of Chapter 105 of the General Statutes is amended by adding a new section to read:

"**§ 105-129.16G. Credit for donating funds to a nonprofit organization to enable the nonprofit to acquire renewable energy property.**

(a) Credit. – A taxpayer who donates money to a tax-exempt nonprofit organization for the purpose of providing funds for the organization to construct, purchase, or lease renewable energy property is allowed a credit under this section if the nonprofit organization uses the donation for its intended purpose. A tax-exempt nonprofit organization is an organization that is exempt from tax under section 501(c)(3) of the Code.

The amount of the credit allowed in this section is the taxpayer's share of the credit the nonprofit organization could claim under G.S. 105-129.16A if the nonprofit organization were subject to tax. The taxpayer's share of the credit is calculated by dividing the taxpayer's donation by the cost of the renewable energy property constructed, purchased, or leased by the nonprofit organization and placed in service during the taxable year and then multiplying this percentage by the amount of the credit the nonprofit organization could claim if it were subject to tax. A taxpayer must take the credit allowed by this section in the year in which the property is placed in service. The installment requirements in G.S. 105-129.16A for nonresidential property do not apply to the credit allowed in this section.

(b) Records. – A nonprofit organization must keep a record of all donations it receives for the purpose of providing funds for the organization to construct, purchase, or lease renewable energy property and of the amount of the donations used for this purpose. If a nonprofit organization places renewable energy property in service that is purchased in whole or in part from donations made for this purpose, the nonprofit organization must give each taxpayer who made a donation a statement setting out the amount of the credit for which the taxpayer qualifies under this section. The statement must describe the renewable energy property placed in service and state the cost of the property, the amount of the credit the nonprofit organization could claim under G.S. 105-129.16A if it were subject to tax, and the taxpayer's share of the credit allowed in this section. If the donations made for the renewable energy property exceed the cost of the property, the nonprofit organization must prorate each taxpayer's share of the credit. The sum of the credits allowed under this section to taxpayers who make donations to a nonprofit organization may not exceed the amount of the credit the nonprofit organization could claim under G.S. 105-129.16A if it were subject to tax.

(c) No Double Benefit. – A taxpayer who claims a credit under this section based on a donation to a nonprofit organization is not allowed to deduct this donation as a charitable contribution."

SECTION 13.(b) G.S. 105-130.5(a) is amended by adding a new subdivision to read:

"(a) The following additions to federal taxable income shall be made in determining State net income:

...

(19) The amount of a donation made to a nonprofit organization for which a credit is claimed under G.S. 1105-129.16G."

SECTION 13.(c) G.S. 105-134.6(c) is amended by adding a new subdivision to read:

"(c) Additions. – The following additions to taxable income shall be made in calculating North Carolina taxable income, to the extent each item is not included in taxable income:

...

(5b) The amount of a donation made to a nonprofit organization for which a credit is claimed under G.S. 105-129.16G."

SECTION 13.(d) G.S. 105-259(b) is amended by adding a new section to read:

"(b) Disclosure Prohibited. – An officer, an employee, or an agent of the State who has access to tax information in the course of service to or employment by the State may not disclose the information to any other person unless the disclosure is made for one of the following purposes:

...

(38) To verify with a nonprofit organization information relating to eligibility for a credit under G.S. 105-129.16G."

SECTION 13.(e) This section is effective for taxable years beginning on or after 1 January 2008.

SECTION 14. The Utilities Commission shall submit to the Governor, the Environmental Review Commission, and the Joint Legislative Utility Review Committee a report on the actual results of the cost allocations established pursuant to G.S. 62-133.7(h), as enacted by Section 2 of this act, G.S. 62-133.8(e) and G.S. 62-133.8(f), as enacted by Section 4 of this act, and G.S. 62-133.2(a2) and G.S. 62-133.2(a3), as enacted by Section 5 of this act, during the preceding two fiscal years on or before 1 October of odd-numbered years. The Utilities Commission shall submit the first report required by this section no later than 1 October 2009.

SECTION 15. If any section or provision of this act is declared unconstitutional or invalid by the courts, the unconstitutional or invalid section or provision does not affect the validity of this act as a whole or any part of this act other than the part declared to be unconstitutional or invalid.

SECTION 16. Sections 1, 2, 6, 7, and 8 of this act become effective 1 January 2008. The provisions of Section 2 of this act that provide for the recovery of costs incurred under Section 2 apply only to costs that are incurred on and after 1 January 2008. Sections 3, 4, 14, 15, and 16 of this act become effective when this act becomes law. The provisions of Section 4 of this act that provide for the recovery of costs incurred under Section 4 apply only to costs that are incurred on and after the date that this act becomes law. Section 5 of this act becomes effective 1 January 2008 provided that (i) the provisions of G.S. 62-133.2, as amended by Section 5 of this act, apply only to fuel and fuel-related costs incurred on and after 1 January 2008 regardless of the test period established by the Utilities Commission, and (ii) the costs described in G.S. 62-133.2(a1)(3) that are incurred on and after the date this act becomes law shall be recoverable as provided in G.S. 62-133.2 as amended by Section 5 of this act. Sections 10, 11, 12, and 13 of this act become effective as provided in those sections. Section 9 of this act becomes effective 1 July 2007.

In the General Assembly read three times and ratified this the 2nd day of August, 2007.

s/ Beverly E. Perdue
President of the Senate

s/ Joe Hackney
Speaker of the House of Representatives

s/ Michael F. Easley
Governor

Approved 3:20 p.m. this 20th day of August, 2007

NC Legislative Commission on Global Climate Change

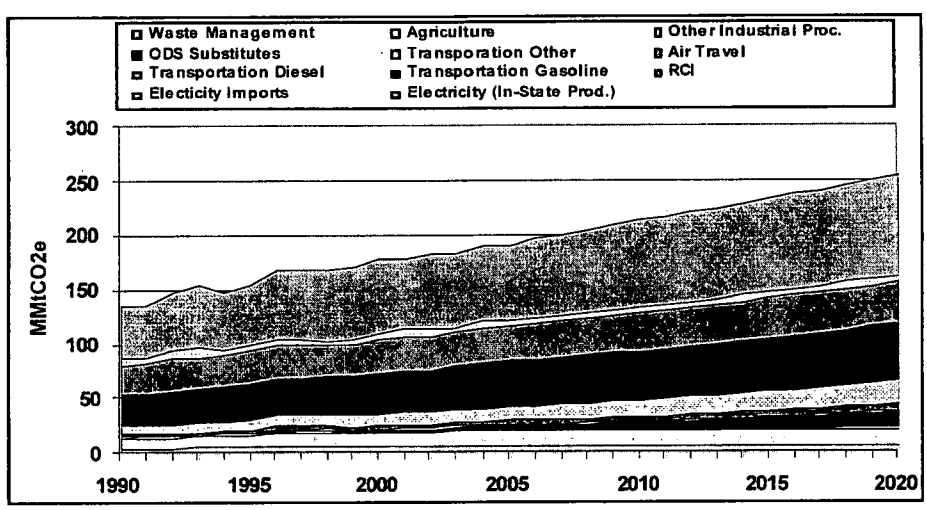
Brock Nicholson DAQ, Tom Peterson CCS

October 23, 2007

ncdenr
North Carolina Department of Environment and Natural Resources

CCS
CENTER FOR CLIMATE STRATEGIES

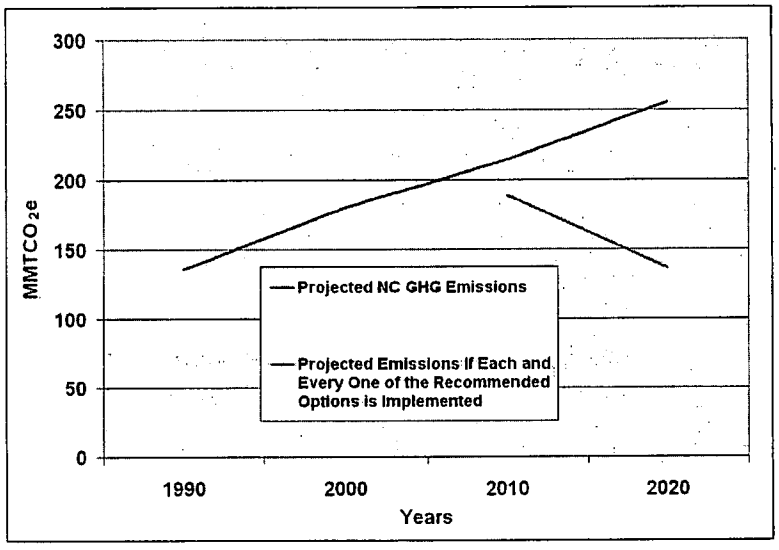
NC Inventory and Forecast of GHG Emissions



CAPAG Mitigation Options

- Final Recommendations (56)
  - Residential, Commercial and Industrial (RCI) - 11
  - Energy Supply (ES) - 13
  - Transportation and Land Use (TLU) - 13
  - Agriculture, Forestry and Waste Mgmt (AFW) - 13
  - Cross Cutting Issues (CC) - 6
- Number previously approved by the LCGCC (16) plus 3 additional LCGCC mitigation recommendations
- Level of Consensus: 48 UC, 8 Supermajority

Total GHG Reduction Potential of 56 CAPAG Recommendations



Potential Results of 56 CAPAG Recommendations

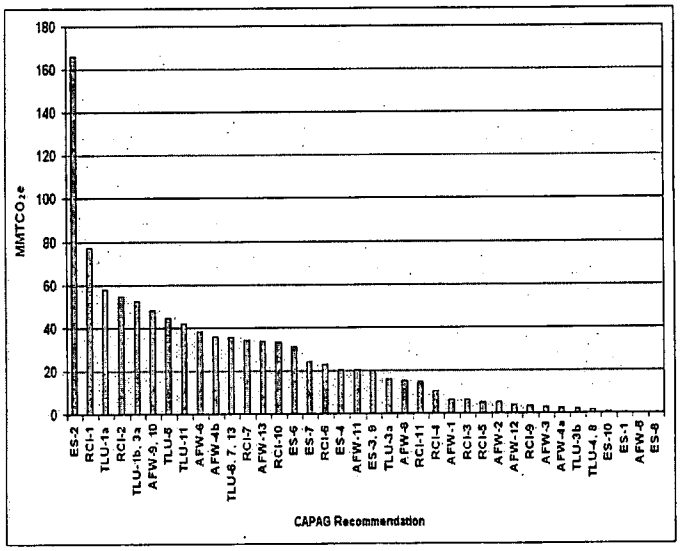
Sector	GHG Reductions ($MMtCO_2e$)			Net Present Value 2007–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)
	2010	2020	Total 2007–2020		
Residential, Commercial and Industrial (RCI, non-electricity options only)	0.1	1.5	7.9	–987	N/A
Energy Supply (ES, including RCI options with impacts on electricity consumption and adjusted for RCI and ES electricity options that overlap)	6.5	62.7	375.0	–5.9	–0.02
Transportation and Land Use	11.1	25.5	232.3	–4,350	–19
Agriculture, Forestry and Waste Management	7.8	29.3	212.5	–222	–1.04
Cross-Cutting Issues	*Non-quantified, enabling options*				
TOTAL (includes all adjustments for overlaps and recent actions)*	**25.5**	**119.0**	**827.7**	**–5,121**	**N/A**

-- 828 MMTCO2 removed
-- $5 billion net economic savings

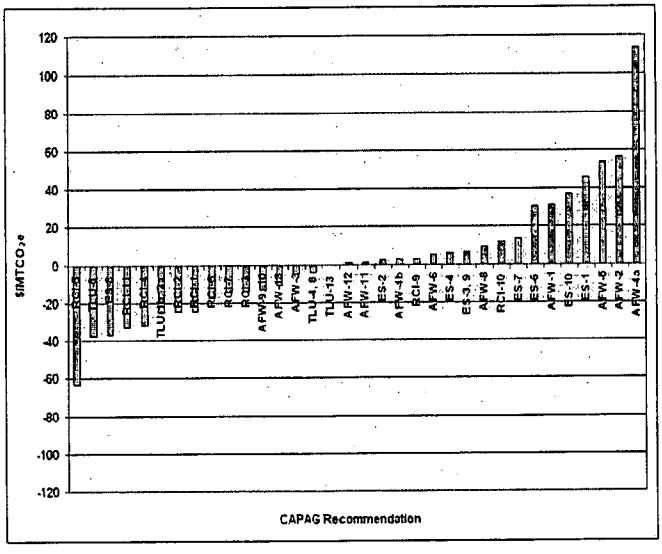
CAPAG Report: Technical Appendices

- Templates for all CAPAG recommendations:
  - Policy description
  - Policy design (goals, timing, coverage…)
  - Estimation of GHG reduction potential and cost/cost savings of implementation
    - Data sources, methods, assumptions, key uncertainties
  - Related policies and programs in place
  - Significant co-benefits if/as needed
  - Significant feasibility issues if/as needed
  - Barriers to consensus if/as needed
  - Final level of support

Tons Reduced per Measure for 56 CAPAG Recommendations



Cost per Ton for 56 CAPAG Recommendations



RCI Recommendations

- Demand Side Management Programs for the RCI Sectors - Recommended Case: "Top-Ten States" EE Investment
- Expand Energy Efficiency Funds
- Energy Efficiency Requirements for Government Buildings
- Market Transformation and Technology Development Programs
- Improved Appliance and Equipment Efficiency Standards
- Building Energy Codes
- "Beyond Code" Building Design Incentives and Targets, Incorporating Local Building Materials and Advanced Construction
- Education (Consumer, Primary/Secondary, Post-Secondary/ Specialist, College and University Programs)
- Green Power Purchasing (required for state facilities) and Bulk Purchasing Programs for Energy Efficiency or Other Equipment
- Distributed Renewable and Clean Fossil Fuel Power Generation
- Residential, Commercial, and Industrial Energy and Emissions Technical Assistance and Recommended Measure Implementation
- *CAPAG recommendations previously approved by the LCGCC in blue

ES Recommendations

- Renewable Energy Incentives
- Environmental Portfolio Standard
- Original Analysis
- 20% Combined Target
- Load Growth Offset Target
- Removing Barriers to CHP and Clean DG
- CO2 Tax and/or Cap-and-Trade
- Electric Sector Only
- Economy-wide
- Legislative Changes to Address Environmental and Other factors
- Incentives for Advanced Coal
- Replacement of New 800 MW Pulverized Coal Plant
- Replacement of Existing 800 MW Pulverized Coal Plant
- Public Benefit Charge
- Waste to Energy
- Incentives for CHP and Clean DG
- NC GreenPower Renewable Resources Program
- *CAPAG recommendations previously approved by the LCGCC in blue

TLU Recommendations

- Land Development Planning
- Multi-Modal Transportation and Promotion (formerly TLU-2)
- Surcharges to Raise Revenue
- Rebates/ Feebates to Change Fleet Mix
- Truckstop Electrification
- Tailpipe GHG Standards
- Biofuels Bundle
- Procure Efficient Fleets
- Idle Reduction/Elimination Policies
- Diesel Retrofits
- Pay-As-You Drive Insurance
- Advanced Technology Incentives
- Buses – Clean Fuels

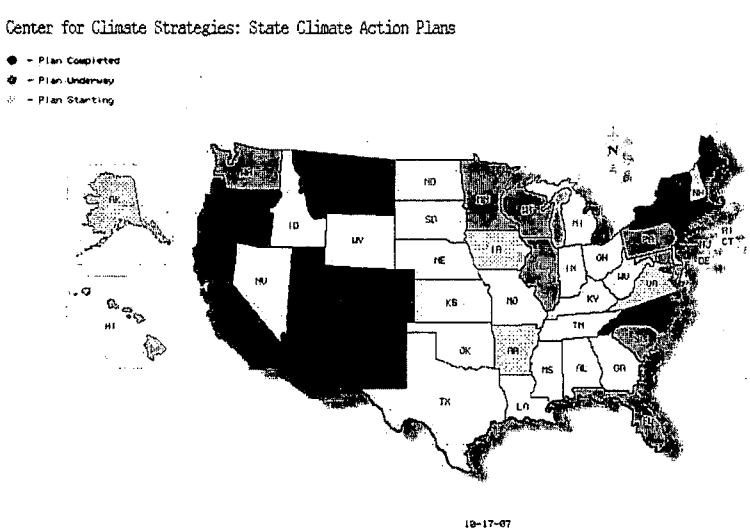
AFW Recommendations

- Manure Digesters & Energy Utilization
- Biodiesel Production (incentives for feedstocks and production plants)
- Soil Carbon Management (including organic prod. methods incentives)
- Preservation of Working Land–Agricultural Land
- Preservation of Working Land–Forest Land (formerly AFW-7)
- Agricultural Biomass Feedstocks for Electricity or Steam Production
- Policies to Promote Ethanol Production
- Afforestation and/or Restoration of Nonforested Lands
- Expanded Use of Forest Biomass and Better Forest Management
- Landfill Methane and Biogas Energy Programs
- Increased Recycling Infrastructure and Collection
- Urban Forestry Measures

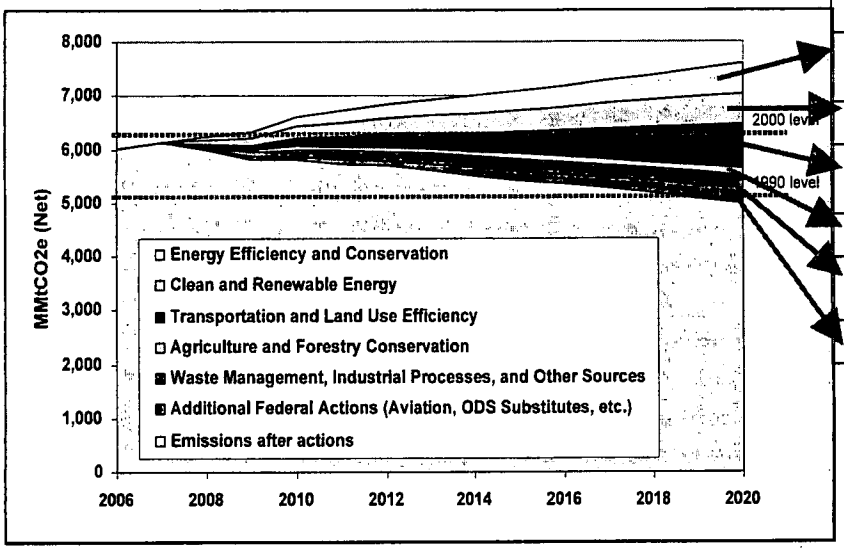
CC Recommendations

- GHG Inventories and Forecasts
- GHG Reporting
- GHG Registry
- Public Education and Outreach
- Adaptation
- Options for Goals or Targets (for CAPAG in support of LCGCC)
- *CAPAG recommendations previously approved by the LCGCC in blue

State Climate Action Plans



Leadership States' "Wedges"



% of Gap	Sample Cost
~24%	-$10 to -$30
~24-30%	$7 to $21
~20-36%	-$32 to -$36
~6-9%	-$1 to -$5
~11-18%	TBD
~6-18%	TBD

State GHG Targets

AZ	2000 levels by 2020; 50% below by 2040
CA	- E.O.: 2000 by 2010; 10% below by 2020; 80% by 2050,; - AB-32: 1990 by 2020
CO	TBD
CT	1990 level by 2010; 10% below by 2020; 75% by 2050
IA	50 to 80% below 1990 by 2050, 2012, 2025 and 2035 targets TBD
IL	1990 levels by 2020; 60% below by 2050
MA	1990 level by 2010; 10% below by 2020; 75% by 2050
ME	1990 by 2010; 10% below by 2020; 75% by 2050
MN	Next Generation Energy Act: 15% below 2005 levels by 2015; 30% by 2025; 80% by 2050
MT	TBD

NC	TBD
NEG /ECP	1990 by 2010; 10% below by 2020; 75-85% ultimately
NJ	E.O.: 1990 by 2020; 80% below 2006 by 2050
NM	2000 by 2012; 10% below by 2020; 75% by 2050
NY	5% below 1990 by 2010
OR	1990 by 2010; 10% below by 2020; 75% by 2100
RI	1990 by 2010; 10% below by 2020; 75% by 2050
VT	25% below 1990 by 2012; 50% below 1990 by 2028; 75% by 2050
WA	- E.O.: 1990 by 2020; 25% below 1990 by 2035; 50% below 1990 by 2050
WI	TBD
WCI	15% below 2005 by 2020, 80% below by 2050

North Carolina



Climate Action Plan Advisory Group (CAPAG)

Recommended Mitigation Options for Controlling Greenhouse Gas Emissions



Draft FINAL Report October 2007

Preface

This report contains recommendations from a voluntary stakeholder advisory group on potential measures to reduce greenhouse gas (GHG) emissions that are worthy of consideration by policy makers in North Carolina. This advisory group represents a broad range of interests in North Carolina. The Climate Action Plan Advisory Group (CAPAG) consists of more than 40 volunteers from business, industry, environmental groups, academia, government and the general public. A consultant, the Center for Climate Strategies (CCS), provided facilitation and technical analysis expertise. From over 300 potential GHG mitigation options, more than 50 were analyzed considering likely GHG reductions, costs and benefits.

Benefit analysis included potential for jobs creation in North Carolina as new measures and technologies are employed. This analysis was conducted in addition to the CAPAG specific work by Appalachian State University and these data and results are presented in this report. [To be added when completed between October and December 2007]

The North Carolina General Assembly created a Legislative Commission on Global Climate Change (LCGCC) in the fall of 2005 to address climate related issues. These issues included whether North Carolina should set a goal for reduction of GHGs in this state, and if so, what that goal should be. CAPAG coordinated closely with the LCGCC and shared several members with that Commission.

This report is not intended to be a climate action implementation plan for North Carolina. Such a plan will come only after State policy makers assess these and other recommendations further. However the data, results and recommendations contained in this report provide valuable guidance for the creation of an action plan(s) for legislative, administrative, regulatory or voluntary action.

Executive Summary

Introduction

In 2002, the North Carolina General Assembly passed, and the Governor signed, the Clean Smokestack Act (CSA). The CSA tasked the North Carolina Department of Environment and Natural Resources' (DENR) Division of Air Quality (DAQ) with studying options for reducing carbon dioxide (CO_2) emissions from coal-burning power plants and other sources. The Act required DAQ to complete a series of studies and make recommendations for reducing North Carolina's carbon emissions.[1, 2, 3] As a result of these studies, DAQ and DENR embarked on efforts to further address the potential reductions of North Carolina's greenhouse gas (GHG) emissions. The DAQ recognized that many potential options that would mitigate GHG emissions also likely have the long term potential to stimulate economic growth and create much needed jobs in the state, regardless of, and in addition to impacts upon climate change.

The final CSA report, submitted to the North Carolina General Assembly in September of 2005, contained a recommendation, that the state continue GHG mitigation planning to consider a public stakeholder process. Thus, the North Carolina Climate Action Plan Advisory Group (CAPAG) was initiated within an open and publicized process to develop recommendations to DENR/DAQ. The purpose was to assemble a diverse group of stakeholders to further identify and assess mitigation options that might be appropriate, carry out analysis and make recommendations that state policy makers should consider for a state-level Climate Action and Implementation Plan. This report provides the results of that process, focusing in addition to GHG reductions on economic opportunities impacts and co-benefits as associated with proposed potential mitigation options.

The CAPAG process was organized by first assembling 43 stakeholders to represent a diverse range of interests and expertise. The CAPAG met seven times from February, 2006 through July, 2007. During this same period, five technical work groups (TWGs) of the CAPAG developed initial recommendations in the areas of: Energy Supply (ES); Residential, Commercial, Industrial (RCI); Transportation and Land Use (TLU); Agriculture, Forestry, and Waste Management (AFW); and Cross-Cutting Issues (CC). These TWGs consisted of both a consultant facilitator and expertise for analysis as well as several experts and interested parties from within each of the sector communities. The membership of the CAPAG and the five TWGs are documented elsewhere in the appendices of this report. The CAPAG followed a consensus-building process designed and facilitated by the non-profit Center for Climate Strategies (CCS). Applying a proven design similar to those used elsewhere, CCS provided both facilitation services and technical analysis to the CAPAG in formulating its recommendations.

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[1] *CO_2 Emission Reduction Options For Coal-fired Electrical Utility Boilers and Other Stationary Sources, First Interim Report,* NC DENR/DAQ, Raleigh, NC, September 1, 2003.

[2] *CO_2 Emission Reduction Options For Coal-fired Electrical Utility Boilers and Other Stationary Sources, Second Interim Report Pursuant to Clean Smokestacks Act,* NC DENR/DAQ, Raleigh, NC, September 1, 2004.

[3] *Recommended Carbon Dioxide (CO_2) Emission Reduction Strategies for North Carolina (Pursuant to North Carolina's Clean Smokestacks Act of 2002),* NC DENR/DAQ, Raleigh, NC, September 1, 2005.

The North Carolina General Assembly in 2005 also formed the Legislative Commission on Global Climate Change (LCGCC) with a charge to among other things, determine if a cap on emissions was warranted, and if so, at what level should it be set. The LCGCC appointed by leaders of both the House and Senate and facilitated by Legislative Counsel and staff, held its first meeting on February 3, 2006. Though the Commission has focused mainly on broader issues, the CAPAG has coordinated closely with them and has become integrated in many of their deliberations.

CAPAG Mitigation Option Recommendations and Impacts

The CAPAG offers 56[4] recommended options for further study and potential adoption that are believed to be most important for mitigating North Carolina's GHG emissions. The level of support among CAPAG members for these options, although not always unanimous, has been very high. As a starting point it was discovered that

- GHG emissions as estimated subsequent to a 1990 baseline have grown at a rate much higher than most areas due to the growth in population and high level of prosperity in this state, as further detailed later in the report. This growth has resulted in large increases in use of electricity, more cars driving more miles, and other consumer trends that have developed.

- Projected emissions can be reduced significantly if each and every one of the CAPAG's recommendations is completely, strictly and properly implemented and the estimated reductions are fully achieved.

- Full adoption by the state and complete, strict and proper implementation of each and every one of the CAPAG's recommendations is estimated to reduce gross GHG emissions by approximately 47%, from 256 million metric tons of carbon dioxide equivalent ($MMTCO_2e$) in the reference case forecast to 137 $MMTCO_2e$ by 2020, or within 1% of 1990 levels.

- Cumulative GHG reductions from 2007-2020 from complete adoption and implementation are estimated to be as high as 828 $MMTCO_2e$.

- The associated economic analysis (considering both plus and minus costs) indicates significant cost savings for the State's economy over the period 2007-2020.

The associated cost savings are defined fully in the following chapters of this report.

Details of the 56 mitigation options and their analysis, over the five sectors, as supported by the CAPAG process and recommendations are presented in Chapters 3 through 7 of this report, and in the Appendices.

As further discussed in Chapter 1, the CAPAG's recommendations complement efforts underway in North Carolina, especially the LCGCC and policies and programs developed by the

[4] This number is based on the total number of options approved by the CAPAG (see Table ExSum-3). Some options were renumbered (i.e., AFW-7 to AFW-4b; TLU 2 to TLU-1b) or combined (e.g., AFW 9&10), and others were divided into sections a, b, c to yield a total of 56 options supported by CAPAG.

North Carolina Energy Office.[5] This report also points to numerous co-benefits that would result from implementation of CAPAG-recommended options.

As this is currently a very active area, we also note that the State Energy Office is currently updating the State Energy Plan. In addition, during the 2007 session of the General Assembly, State Legislators adopted, and Governor Easley signed, several bills related to mitigation options also considered by the CAPAG, particularly relating to a requirement for North Carolina utilities to use renewable energy and energy efficiency programs and to require the state to increase energy efficiency in existing and new state-owned and leased buildings. Time and resources have not allowed a full integration of these actions into the recommendations included in this report. A summary of the CAPAG's 56 Mitigation Options by sector is provided below:

	Mitigation Option Name	Cumulative GHG Reductions 2007-2020 $MMTCO_2e$
	Residential, Commercial, and Industrial (RCI)	
RCI–1	Demand Side Management Programs for the RCI Sectors - Recommended Case: "Top-Ten States" EE Investment	77.1
RCI–2	Expand Energy Efficiency Funds	54.8
RCI–3	Energy Efficiency Requirements for Government Buildings	6.4
RCI–4	Market Transformation and Technology Development Programs	10.5
RCI–5	Improved Appliance and Equipment Efficiency Standards	5.3
RCI–6	Building Energy Codes	23.1
RCI–7	"Beyond Code" Building Design Incentives and Targets, Incorporating Local Building Materials and Advanced Construction	34.2
RCI–8	Education (Consumer, Primary/Secondary, Post-Secondary/ Specialist, College and University Programs)	NA
RCI–9	Green Power Purchasing (required for state facilities) and Bulk Purchasing Programs for Energy Efficiency or Other Equipment	3.5
RCI–10	Distributed Renewable and Clean Fossil Fuel Power Generation	33.5
RCI–11	Residential, Commercial, and Industrial Energy and Emissions Technical Assistance and Recommended Measure Implementation	14.9
	SECTOR TOTAL AFTER ADJUSTING FOR OVERLAPS	218.7
	RCI REDUCTIONS FROM RECENT ACTIONS**	10.1
RCI–1	Demand Side Management Programs for the Residential, Commercial and Industrial Sectors	6.2
RCI–2	Expand Energy Efficiency Funds	3.6
RCI–6	Building Energy Codes	0.0
RCI–9	Green Power Purchasing (required for state facilities) and Bulk Purchasing Programs for Energy Efficiency or Other Equipment	0.3
	SECTOR TOTAL PLUS RECENT ACTIONS	228.8

[5] See Annex A to Appendix E (Residential, Commercial and Industrial Sectors) for summaries of the North Carolina State Energy Office (SEO) and State Energy Plan (SEP) policies and programs related to RCI mitigation options.

	Mitigation Option Name	Cumulative GHG Reductions 2007-2020 $MMTCO_2e$
	Energy Supply (ES)	
ES-1	Renewable Energy Incentives	0.33
ES-2	Environmental Portfolio Standard	
ES-2a	Original Analysis	288.7
ES-2b	20% Combined Target	166.2
ES-2c	Load Growth Offset Target	160.3
ES-3	Removing Barriers to CHP and Clean DG	20.1
ES-4	CO_2 Tax and/or Cap-and-Trade	
ES-4a	Electric Sector Only	20.4
ES-4b	Economy-wide	47.7
ES-5	Legislative Changes to Address Environmental and Other factors	**NA**
ES-6	Incentives for Advanced Coal	
ES-6a	Replacement of New 800 MW Pulverized Coal Plant	31.0
ES-6b	Replacement of Existing 800 MW Pulverized Coal Plant	42.9
ES-7	Public Benefit Charge	24.4
ES-8	Waste to Energy	0.02
ES-9	Incentives for CHP and Clean DG	**NA**
ES-10	NC GreenPower Renewable Resources Program	0.95
	SECTOR TOTAL AFTER ADJUSTING FOR OVERLAPS*	375
	REDUCTIONS FROM RECENT ACTIONS (none)	0
	SECTOR TOTAL PLUS RECENT ACTIONS*	375
	Transportation and Land Use (TLU)	
TLU-1a	Land Development Planning	58.2
TLU-1b	Multi-Modal Transportation and Promotion (formerly TLU-2)	52.4
TLU-3a	Surcharges to Raise Revenue	15.7
TLU-3b	Rebates/ Feebates to Change Fleet Mix	2.8
TLU-4	Truckstop Electrification	**NA**
TLU-5	Tailpipe GHG Standards	44.5
TLU-6	Biofuels Bundle	35.4
TLU-7	Procure Efficient Fleets	**NA**
TLU-8	Idle Reduction/Elimination Policies	2.2
TLU-9	Diesel Retrofits	13.5
TLU-11	Pay-As-You Drive Insurance	42.0
TLU-12	Advanced Technology Incentives	**NA**
TLU-13	Buses – Clean Fuels	**NA**
	SECTOR TOTAL AFTER ADJUSTING FOR OVERLAPS	232.3
	REDUCTIONS FROM RECENT ACTIONS (none)	0
	SECTOR TOTAL PLUS RECENT ACTIONS	232.3

	Mitigation Option Name	Cumulative GHG Reductions 2007-2020 $MMTCO_2e$
	Agriculture, Forestry, and Waste (AFW)	
AFW-1	Manure Digesters & Energy Utilization	6.4
AFW-2	Biodiesel Production (incentives for feedstocks and production plants)	5.1
AFW-3	Soil Carbon Management (including organic prod. methods incentives)	3.0
AFW-4a	Preservation of Working Land–Agricultural Land	2.6
AFW-4b	Preservation of Working Land–Forest Land (formerly AFW-7)	36
AFW-5	Agricultural Biomass Feedstocks for Electricity or Steam Production	0.2
AFW-6	Policies to Promote Ethanol Production	38
AFW-8	Afforestation and/or Restoration of Nonforested Lands	15
AFW-9&10	Expanded Use of Forest Biomass and Better Forest Management	48
AFW-11	Landfill Methane and Biogas Energy Programs	20
AFW-12	Increased Recycling Infrastructure and Collection	4.1
AFW-13	Urban Forestry Measures	34
	SECTOR TOTAL AFTER ADJUSTING FOR OVERLAPS	213
	REDUCTIONS FROM RECENT ACTIONS (none)	0
	SECTOR TOTAL PLUS RECENT ACTIONS	213
	Cross-Cutting Issues (CC)	
CC-1	GHG Inventories and Forecasts	**NA**
CC-2	GHG Reporting	**NA**
CC-3	GHG Registry	**NA**
CC-4	Public Education and Outreach	**NA**
CC-5	Adaptation	**NA**
CC-6	Options for Goals or Targets (for CAPAG in support of LCGCC)	**NA**

Some options were renumbered (i.e., AFW-7 to AFW-4b; TLU 2 to TLU-1b) or combined (e.g., AFW 9&10), and others were divided into sections a, b, c to yield a total of 56 options supported by CAPAG.

** "Recent actions" represent initiatives undertaken in North Carolina that reduce GHG emissions that were implemented shortly before or during the CAPAG process. The emission reductions associated with recent actions are not accounted for in the GHG emissions inventory and reference case projections. Emissions reductions associated with these recent actions were therefore estimated separately, and are counted toward overall statewide reductions along with reductions from the mitigation options recommended by the CAPAG.

Perspectives on Mitigation Option Recommendations

There can be a large variation in the GHG reductions associated with various options. These are discussed in substantially more detail in the following chapters and appendices, as well as details of the costs, cost per ton, figures showing the net reductions, and other details of how the information was developed.

Jobs Analysis of Mitigation Options

The jobs analysis could not be completed until the detailed reductions and cost information were available from the initial CAPAG effort. Appalachian State University and CCS and their team of analysts completed the analyses of the impact of these recommendations in a separate process. These analyses have not been reviewed and considered by the CAPAG, and were not available for inclusion in this report but will be provided to CAPAG at the October 16, 2007 review meeting. These results and discussion will be added to the final version of this report after these steps are completed.

Chapter 1
Background and Overview

The Climate Action Planning Initiative

North Carolina leaders, including the General Assembly, have acted upon concerns that North Carolina would be prudent to examine steps that could and should be taken to address climate change and any man made components of the problem. The concerns include potential that the state's vast coastal areas and other resources may suffer damage from climate changes. In 2002 the North Carolina General Assembly passed, and the Governor signed, a major bill, commonly known as the Clean Smokestack Act (CSA), that is resulting in major reductions in sulfur dioxide (SO_2) and oxides of nitrogen (NO_x) emissions from coal-fired power plants.

The CSA also charged the North Carolina Division of Air Quality (DAQ) with studying and reporting on controls for carbon dioxide (CO_2) emissions from coal-fired electric power plants. This resulted in a series of reports with recommendations for reducing North Carolina's carbon emissions. One of those recommendations was to develop a climate action plan. Under the CSA's Section 13 requirements, the Division released a draft inventory and forecast of the state's GHG emissions as well as the third report (September 2005) with a list of recommendations assembled by the Division.

The Center for Climate Strategies (CCS), a non-profit organization with expertise and a history of similar efforts regarding greenhouse gas (GHG) emissions, prepared the draft inventory and forecast under contract. The Center also made recommendations on a process which would result in a prioritized list of GHG mitigation options. Following the publication of the September 2005 report, the North Carolina Department of Environment and Natural Resources (DENR) with management supplied by the DAQ, initiated a follow up to that report and began the first steps toward a comprehensive climate action plan by commencing a facilitated stakeholder process to consider potential mitigation options.

During this period, the state General Assembly also established the Legislative Commission on Global Climate Change (LCGCC) to assess GHG concerns and, among other things, provide a recommendation to the General Assembly regarding whether the state should establish a cap on emissions, and if so, what that cap should be. The Commission held its first meeting in February 2005 and initiated a climate-related fact-finding effort regarding the science and potential recommendations. The DAQ (assisted with support from CCS) was asked to provide technical background and implementation support to the work of the LCGCC. This cooperative effort was initiated and is expected to continue through the Commission's life, now set as April 2008.

DAQ recognized that it was possible, and even likely, that many potential GHG mitigation options would stimulate economic growth and new jobs in the state, in addition to reducing the effects of climate change. Thus, a stakeholder process was initiated which called on over 40 volunteer stakeholders representing a broad range of interests and expertise to be formed into a body to be called the Climate Action Plan Advisory Group (CAPAG). This diverse group of North Carolina citizens, representing business, industry, environmental and educational organizations and government, took on the responsibility of analyzing and making

recommendations for priority options to reduce GHG emissions in the state. Many of the CAPAG members were also members of the LCGCC. Their work included:

- Development, prioritization, analysis and approval of a final collection of existing and proposed actions that could contribute to GHG emissions reductions.
- Review and approval of an inventory of historical and forecasted GHG emissions in North Carolina as a basis against which to gauge priorities and progress
- Consideration of costs and benefits of recommended options.

This report is the outcome of that effort, one that involved a distinguished and broad group of stakeholders including other state agencies, with technical support and facilitation from the CCS.

Recent Developments

North Carolina has undertaken several efforts to conserve energy while addressing GHG emissions. The North Carolina State Energy Office has developed and is currently updating the State Energy Plan.[1] Examples of efforts undertaken by other entities include the following:

- *Major utilities in North Carolina have expanded existing demand-side management programs (DSM) for the RCI sectors.*
- *Under the authority of the North Carolina Utilities Commission, a Public Benefits Charge is collected on electricity sales, a portion of which is managed by the Advanced Energy Corporation and used to fund energy efficiency and economic development programs.*
- *NC GreenPower coordinates a voluntary program of green power purchasing for consumers in the governmental, residential, commercial and industrial sectors.*
- *The state fleet of vehicles has been required (and this requirement continues to expand) to meet several standards goals related to make the fleet Flex-fueled and to increase the purchase of hybrid and other high mileage/low emitting vehicles.*
- In addition, during the 2007 session of the General Assembly, State legislators considered several bills related to mitigation options also considered by the CAPAG. The following lists legislation passed by State Legislatures that has been passed and ratified by the Governor. Note that the CAPAG had completed analysis of its mitigation options before the final requirements of these bills were determined. As a result, the GHG reductions and costs (or cost savings) reflected in this report have not been aligned specifically with these new statutes.

[1] See Annex A to Appendix E (Residential, Commercial and Industrial Sectors) for summaries of the North Carolina State Energy Office (SEO) and State Energy Plan (SEP) policies and programs related to RCI mitigation options. Also note that that plan is now being updated.

- Senate Bill (SB) 3 (Promote Renewable Energy/Energy Efficiency) includes the following:
  - Requires a percentage of energy sales in North Carolina to come from new renewable sources and efficiency measures on the following schedule: 3% by 2012 (up to 0.75% from efficiency); 6% by 2015 (up to 1.5% from efficiency); 10% by 2018 (up to 2.5% from efficiency); and 12.5% by 2021 (up to 5% from efficiency).
  - Requires small amounts of electricity sales from: (1) solar (0.02% in 2010 up to 0.2% in 2018); (2) swine waste (0.07% in 2012 up to 0.2% in 2018); and (3) poultry waste (170,000 megawatt hours in 2012 up to 900,000 megawatt hrs in 2014.
  - Contains provisions requiring any new biomass energy facility to meet Best Available Control Technology (BACT). Other language was included to ensure that renewable energy technologies no not have secondary, undesirable consequences. Impacts on residential consumers must not exceed $10 per year 2008-2011; $12 per year 2012-2014; and $34 per year 2015 and beyond.
  - Provisions allow utilities to raise rates to recover expenses for power plant construction prior to the plant being completed. However, the Utilities Commission provides an ongoing review of construction costs and the inclusion of construction costs in rates.
- SB 567 (Allow Distribution of E-Blend Fuels) - Allows E85 to be dispensed from dispensers approved for E10 provided the manufacturer has initiated the process for approval by an independent testing lab.
- SB 1272 (Definition of Biodiesel) - An individual that produces biodiesel for use in a private (non-commercial) vehicle is exempt from the motor fuels tax.
- SB 1277 (State Diesel Vehicles' Warranties/B20 Fuel) - Every new diesel vehicle purchased by the State shall be covered by an express manufacturer's warranty that allows the use of B20 fuel.
- SB 1452 (Diesel School Buses to Use Minimum B20 Fuel) - Requires that 2% of the annual diesel used by North Carolina school buses be B20 by June 2008 (2% = ~ 500,000 gallons).
- SB 668 (Energy Conservation in State Buildings) - Energy Conservation in State Buildings – Specific performance criteria and goals for sustainable, energy efficient public buildings must be established.
- SB 670 (Energy Devices That Use Renewable Resources) - Use of Solar Collectors on detached single-family residences – As long as they aren't facing public access or common areas, an ordinance, deed restriction, covenant and other similar agreements cannot prohibit or have the effect of prohibiting their installation.

The CAPAG Process

The CAPAG first met in February of 2006 and was charged with making recommendations to DAQ that would then be a resource list and as input to further state consideration and proposals for action. The CAPAG met seven times with the final decisional meeting held in July 2007. In addition a meeting to review this report's capture of the intent of the members of CAPAG was held in October 2007. In all, over 75 meetings and significant conference calls of the CAPAG and their supporting technical work groups (TWGs) were held between February 2006 and July, 2007 to identify and analyze various potential mitigation actions. Teleconferences for the pending jobs analysis would expand that number well beyond 80.

The CAPAG was assisted and supported by, five TWGs representing local and outside expertise in key sectors selected for analysis: Energy Supply (ES); Residential, Commercial, Industrial (RCI); Transportation and Land Use (TLU); Agriculture, Forestry, and Waste Management (AFW); and Cross-Cutting Issues (CC). The TWGs consisted of CAPAG members as well as individuals not on the CAPAG with interest and expertise in the issues being addressed by each TWG. CAPAG members as well as individuals not on the CAPAG with interest and expertise in the issues being addressed formed each TWG. Where members of the TWG did not fully agree upon recommendations to the CAPAG, the summary of their efforts was reported to the CAPAG for their further consideration and actions. (See Appendix B for a listing of the members of each group.)

The CAPAG process involved a model of informed self-determination through a facilitated stepwise consensus building approach. Under the oversight of DENR, the process was conducted by the CCS, an independent, expert facilitation and technical analysis team. It was based on procedures that CCS consultants have used in a number of other state climate change planning initiatives since 2000, but adapted specifically for North Carolina. The CAPAG process sought, but did not mandate consensus, and it explicitly documented the level of CAPAG support for individual mitigation options and key findings established through a voting process, outlined and agreed to in advance.

The 56 top priority (out of over 300 total) recommendations adopted by the CAPAG and presented in this report underwent two levels of screening by the CAPAG. First, a potential mitigation option being considered by a TWG was not accepted as a "priority for analysis" and developed for full analysis unless it had a supermajority of support from CAPAG members present at the decisional meetings (with a "supermajority" defined as 80% or more of the CAPAG members attending a meeting agree). Second, after the analyses were conducted, only options that received at least majority support from CAPAG members present at the decisional meetings were adopted by the CAPAG and included in this report. In total, of the 56 recommended mitigation options adopted by the CAPAG, more than 85% (48) received unanimous consent, and just over 14% (8) received a majority of support, of those present at the CAPAG decisional meetings. The TWGs recommendations to the CAPAG were documented and presented to the CAPAG at each CAPAG meeting. All meetings were open to the public, were widely advertised, and all materials for and summaries of the CAPAG and TWG meetings were posted on the project website.

Analysis of Options

With CCS providing facilitation and technical analysis, the TWGs prepared mitigation options for CAPAG consideration using a "mitigation option template" conveying key information:

- Mitigation option description
- Mitigation option design (goals, timing, parties involved)
- Implementation mechanisms
- Related policies / programs in place
- Type(s) of GHG reductions
- Estimated GHG reductions and costs (or cost savings)
- Key uncertainties
- Additional benefits and costs
- Feasibility issues
- Status of group approval
- Level of group support
- Barriers to consensus

In its deliberations, the CAPAG modified and embraced various mitigation options. The final versions for each sector, conforming to the mitigation option templates, appear in Appendices E through I and constitute the most detailed record of decision of the CAPAG. Appendix D presents a description of the methods used for quantification of mitigation options. Three key methods are summarized here:

- *Estimates of GHG reductions.* Using the projection of future GHG emissions (see below) as a starting point, analysis of the impact of mitigation options produced estimates of the GHG reductions attributable to each option in the years 2010 and 2020, and cumulative over the time period 2007-2020. Many options were estimated to affect the quantity or type of fossil fuel combusted; others affected methane (CH_4) or CO_2 sequestered, etc. Among the many assumptions involved in this task was selection of the appropriate GHG accounting framework, namely, the choice between taking a "production-based" approach versus a "consumption-based" approach to various sectors of the economy.[2] The CAPAG took a "production-based" approach in all sectors except the electricity sector, in both forecasting emissions and in estimating the GHG impacts of mitigation options. This issue, along with other GHG estimation issues (e.g., analysis of overlapping or interacting mitigation option impacts), are discussed in detail in Chapter 2 (GHG Inventory and Reference Case Projections), Appendix D (Methods for Quantification), and Chapters 3 through 6 and Appendices E through H for each sector.

[2] In brief, a production-based approach estimates GHG emissions associated with goods and services produced within the state, and a consumption-based approach estimates GHG emissions associated with goods and services consumed within the state. In some sectors of the economy, these two approaches may not result in significantly different numbers, however, the power sector is notable in that it is responsible for large quantities of GHG emissions, and states often produce far more or far less electricity than they consume (with the remainder attributable to power exports or imports). North Carolina imports electric power and must account for the emissions this consumption creates, even though they are not produced in-state.

- *Estimates of cost.* CCS and the TWGs produced estimates of the cost of various mitigation options, both in terms of a net present value from 2007-2020 and a dollars-per-ton cost (i.e., cost-effectiveness).[3] The approach used was similar to a conventional cost-benefit framework but had some important differences:

  — *Benefits vs. costs.* The principal benefit of the CAPAG options is reduced GHG emissions and these were quantified simply as metric tons. There was no attempt to monetize the benefit of these reductions in atmospheric concentration (e.g., health benefits). Many options did create easily monetized non-GHG benefits (e.g., fuel savings and electricity savings). In these cases, monetized benefits were subtracted from monetized costs, resulting in net costs. These net costs could be positive or negative; negative costs indicated that the option saved money or produced "cost savings."

  — *Direct vs. Indirect Effects.* Cost estimates were based on "direct effects" (i.e., those borne by the entities implementing the option).[4] Implementing entities could be: individuals, companies, and/or government agencies, etc. In contrast, conventional cost-benefit analysis takes the "societal perspective" and tallies every conceivable impact on every entity in society (and quantifies these wherever possible).

  — *North Carolina vs. National/Global perspective.* Cost estimates were based on implementing entities in North Carolina, not on a broader societal perspective (national or global). One implication of this is that national taxes or subsidies that affect actions in North Carolina were not part of the analysis.

  — *Discounted and "Levelized" Costs.* Fairly standard approaches were taken here. The "present value" of costs was calculated by applying a real discount rate of 5%. Dollars-per-ton estimates were derived as a "levelized" cost per ton, dividing the "present value cost" by the cumulative GHG reduction measured in tons. As was the case with GHG reductions, the period 2007-2020 was analyzed.

- *Contributing issues.* The CAPAG recommendations were guided in part by the GHG reductions and monetized costs and benefits of various options, but members also felt that other considerations should also have weight. The CAPAG developed a checklist for TWGs to use to keep in mind important human, social, economic, environmental, and other factors that may warrant consideration when evaluating GHG emission reduction strategies. The TWGs were asked to examine these qualitative terms where deemed important, and quantify them on a case-by-case as needed depending on need and where data were readily available.

[3] The analysis addressed cost and did not attempt to estimate specific price changes or utility rate changes that might result from implementation of a mitigation option.

[4] "Additional benefits and costs" were defined as those borne by entities other than those implementing the option. These indirect effects were quantified on a case-by-case basis depending on magnitude, importance, need and availability of data.

North Carolina GHG Emissions Inventory and Reference Case Projections

In support of requirements to the CSA and in cooperation with DENR, CCS prepared a draft document, entitled *Revised Draft North Carolina Greenhouse Gas Inventory and Reference Case Projections 1990-2020* (hereafter *Inventory and Projections*).[5] The projection of future emissions aimed to capture as accurately as possible the trajectory of emissions given policies and programs in place as of 2004. The draft was presented to the CAPAG at its first meeting, and then approved by unanimous consent at the CAPAG's fifth meeting following technical review and revision.[6] The *Inventory and Projections* included detailed coverage of all economic sectors and GHGs in North Carolina, including future emissions trends and assessment issues related to energy, economic, and population growth. The assessment included estimates of total statewide "gross emissions" (leaving aside carbon sequestration[7]) and "net emissions" (in which reductions due to sequestration are subtracted from gross emissions) on a production basis for all sources and a consumption basis for the electricity sector (see prior discussion under "Analysis of Options" in this chapter for an explanation of the production versus consumption approach). Further discussion of the issues involved in developing the inventory and reference case projections is summarized in Chapter 2 (Inventory and Projections of GHG Emissions) and discussed in detailed in the final report for the *Inventory and Projections.*

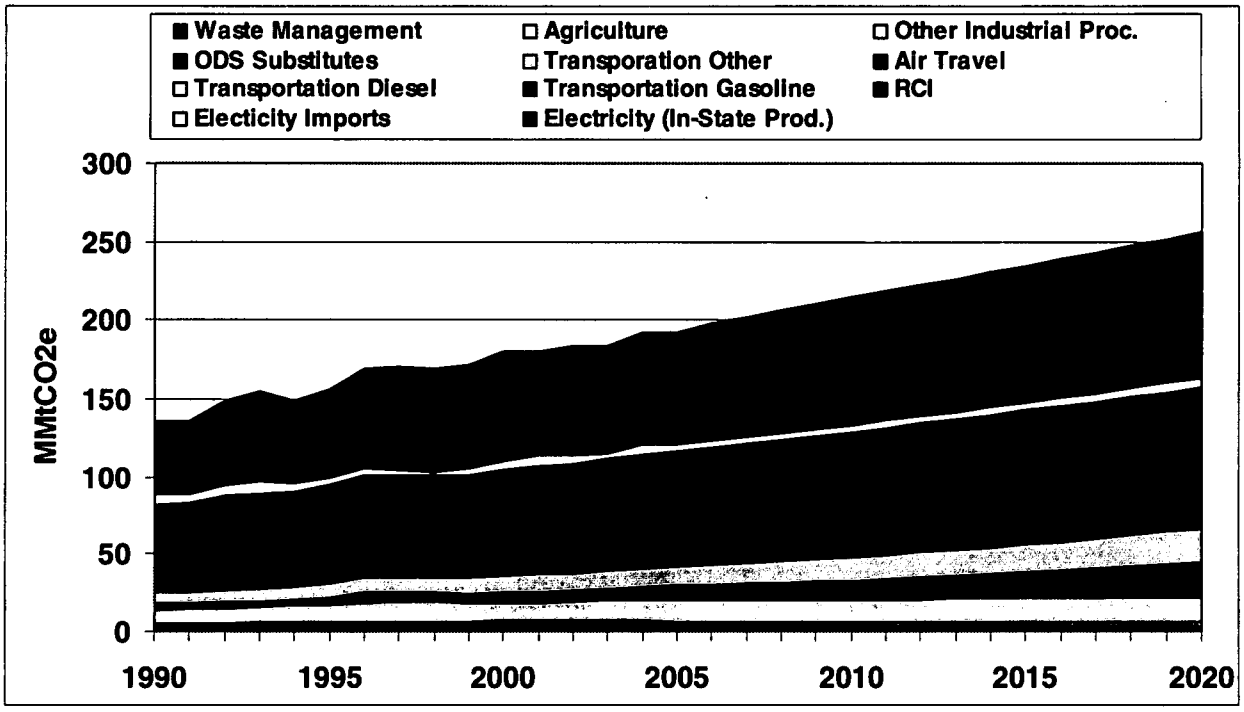
The *Inventory and Projections* revealed substantial emissions growth rates and related mitigation challenges. Figure 1-1 shows the reference projections for North Carolina's gross GHG emissions (not counting sequestration) as rising fairly steeply to 256 $MMtCO_2e$ by 2020, growing by 88% over 1990 levels. Figure 1-1 also provides the sectoral breakdown of forecasted GHG emissions. Accounting for sequestration in North Carolina's forests and soil would decrease the gross estimates from 23 to 24 $MMtCO_2e$ per year. On a net emissions basis (using the consumption-based approach), North Carolina's GHG emissions grow by about 106% over 1990 levels (about 232 $MMtCO_2e$ in 2020).

[5] *Revised Draft North Carolina Greenhouse Gas Inventory and Reference Case Projections 1990-2020*, prepared by the Center for Climate Strategies for the North Carolina DENR/DAQ, February 2006, http://www.ncclimatechange.us/capag.cfm.

[6] *Final North Carolina Greenhouse Gas Inventory and Reference Case Projections 1990-2020*, prepared by the Center for Climate Strategies for the North Carolina DENR/DAQ, September 2007, http://www.ncclimatechange.us/capag.cfm.

[7] Sequestration refers to the storing of carbon in mines, brine strata, oceans, plants and soil. As trees and other plants grow they remove CO_2, the principal GHG, from the atmosphere transforming the carbon (C) through photosynthesis into cellulose, starch and sugars, thus sequestering it in their structures and roots. The oxygen (O_2) is released back into the atmosphere. North Carolina's forests and agricultural lands are capable of sequestering much CO_2, as described in Chapter 6 (Agriculture, Forestry and Waste Management).

Figure 1-1. Gross GHG Emissions by Sector, 1990-2020: Historical and Projected (Consumption-based Approach) Business as Usual/Base Case



The inventory and projection of North Carolina's GHG emissions provided several critical findings, including:

- As is common in many states, the electricity and transportation sectors are the two sectors with the largest emissions, and are expected to continue to grow faster than other sectors.

- Consumption of electricity is growing faster in North Carolina than population. In addition, there appears to be a trend toward an increasing reliance on natural gas and imported electricity. Vehicle-miles traveled (VMT) are also projected to grow faster than the state's population. Freight traffic (resulting in increased diesel consumption) and increasing use of hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) as substitutes for ozone-depleting substances (ODS) in refrigeration, air conditioning, and other applications is also increasing more rapidly than population.

While North Carolina's emissions estimated growth rate (88% from 1990 to 2020 on a gross emissions, consumption basis) presents challenges, it also provides major opportunities. Key choices on technologies and infrastructure can have a significant impact on the emissions of a fast-growing state. The CAPAG's recommendations document the opportunities for the state to reduce its GHG emissions while continuing its strong economic growth by being more energy efficient, using more renewable energy sources, and increasing the use of cleaner transportation modes, technologies, and fuels. The inventory and reference case projections are discussed in

more detail in Chapter 2 of this report and the entire study appears in the final report for the *Inventory and Projections.*[8]

Overview of CAPAG Mitigation Option Recommendations

The CAPAG offers 56[9] recommended options to DENR for mitigating North Carolina's GHG emissions. Among the CAPAG members that attended each decisional meeting, the level of support for these options is very high; 86% (48 options) received unanimous consent, and 14% (8 options) received a super majority. Figure 1-2 below presents:

- Projected growth in North Carolina's gross GHG emissions on a consumption basis (blue line). The consumption based approach accounts for emissions associated with the generation of electricity in-state and imported from out-of-state to meet North Carolina's demand for electricity.

- Projected emissions if each and every one of the CAPAG's recommendations is completely, strictly and properly implemented and the estimated reductions are fully achieved (green line).

As the figure illustrates, full adoption by the state and complete, strict and proper implementation of each and every one of the CAPAG's recommendations are projected to reduce gross GHG emissions (consumption basis) by approximately 47%, from 256 million metric tons of carbon dioxide equivalent ($MMTCO_2e$) in the reference case forecast to 137 $MMTCO_2e$ by 2020. Implementation of CAPAG's recommendations would thus be estimated to reduce North Carolina's gross GHG emissions to within 1% of 1990 levels by 2020. Table 1-1 provides the numeric estimates underlying Figure 1-2. Table 1-3 shows the estimated GHG reductions; costs or savings from each option; and, its cost effectiveness (cost or savings per ton of reduction). Detailed descriptions and analysis of these options are presented in Chapters 3 through 7 of this report, and in the Appendices.

[8] Detailed documentation of the inventory and reference case projections is provided in *Final North Carolina Greenhouse Gas Inventory and Reference Case Projections, 1990-2020, prepared by the Center for Climate Strategies for the North Carolina DENR/DAQ, September 2007*, http://www.ncclimatechange.us/capag.cfm.

[9] This number is based on the total number of options approved by the CAPAG (see Table ExSum-3). Some options were renumbered (i.e., AFW-7 to AFW-4b; TLU 2 to TLU-1b) or combined (e.g., AFW 9&10), and others were divided into sections a, b, c to yield a total of 56 options supported by CAPAG.

Figure 1-2
Annual GHG Emissions: Reference Case Projections and CAPAG Recommendations (Consumption-Basis, Gross Emissions)

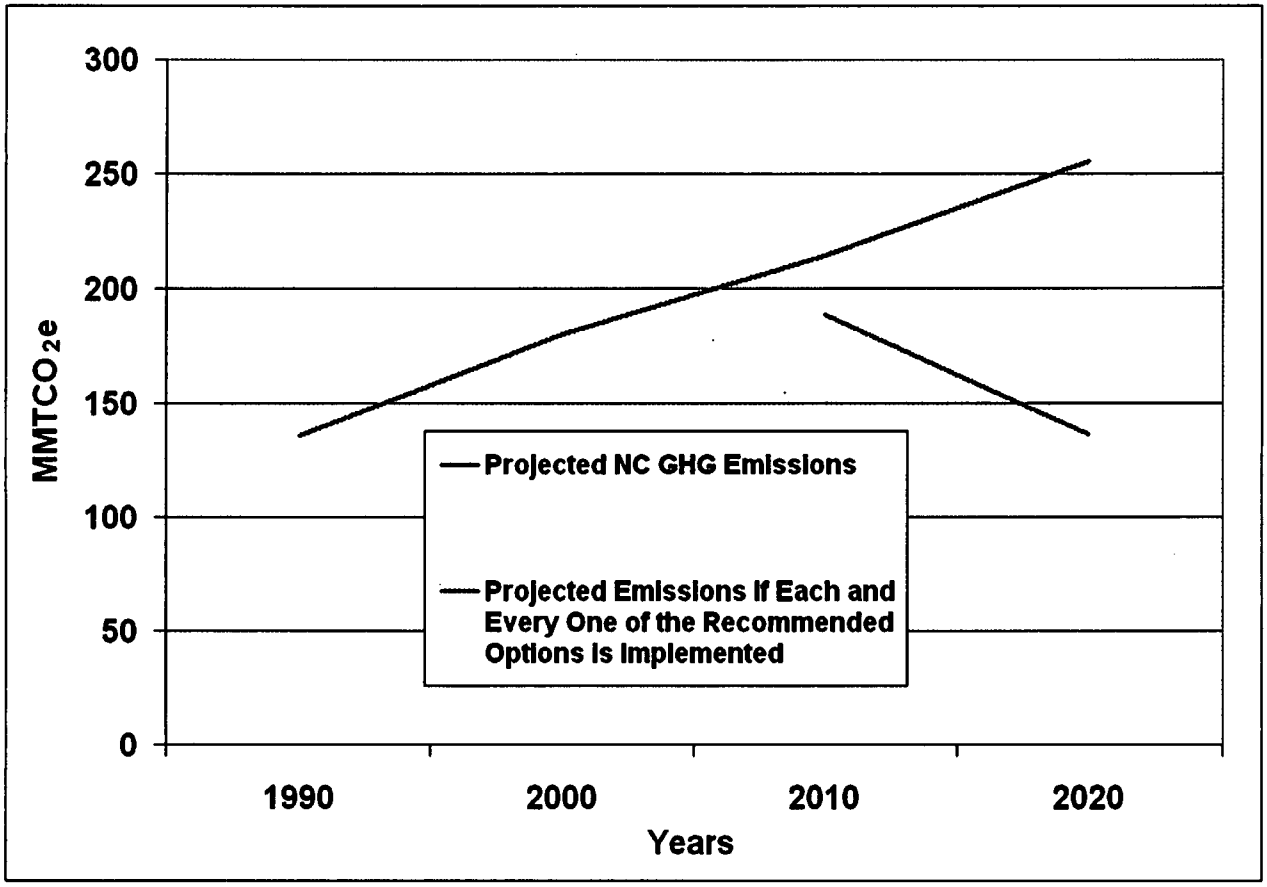


Table 1-1
Annual Emissions: Reference Case Projections, and Impact of CAPAG Recommendations (Consumption-Basis, Gross Emissions)

Annual Emissions ($MMTCO_2e$)	1990	2000	2010	2020
Reference Case Projections	135.6	180.1	214.5	255.6
GHG Reductions From CAPAG Recommendations			25.5	119.0
Annual Emissions With CAPAG Recommendations			189.0	136.6

The CAPAG's recommendations tabulated in the Executive Summary, along with a listing of the estimated reductions for each. Chapters 3 through 7 and the Appendices provide detailed

descriptions and analysis of GHG reductions, costs, additional impacts, feasibility, etc. for individual options developed by the five TWGs/sectors:

- Residential, Commercial, Industrial (RCI)
- Energy Supply (ES)
- Transportation and Land Use (TLU)
- Agriculture and Forestry (AF)
- Cross Cutting Issues (CC)

Table 1-2
Summary by Sector of Estimated Impacts of Implementing All of the CAPAG Recommendations

Sector	GHG Reductions ($MMtCO_2e$)			Net Present Value 2007–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)
	2010	2020	Total 2007-2020		
Residential, Commercial and Industrial (RCI, non-electricity options only)	0.1	1.5	7.9	-987	N/A
Transportation and Land Use	11.1	25.5	232.3	-4,360	-19
Cross-Cutting Issues	*Non-quantified, enabling options*				
TOTAL (includes all adjustments for overlaps and recent actions)*	**25.5**	**119.0**	**827.7**	**-5,121**	**N/A**

*Notes: Negative values in the Net Present Value and the Cost-Effectiveness columns represent net *cost savings* associated with the options. Within each sector, values have been adjusted to eliminate double counting for options or elements of options that overlap. In addition, values associated with options or elements of options within a sector that overlap with options or elements of options in another sector have been adjusted to eliminate double counting.

N/A = Not available; for RCI non-electricity options, an overall cost-effectiveness value is not provided because dividing the net non-electric cost savings (mostly due to natural gas energy efficiency) by the net non-electric emission reductions (which factors in both additional fuel for combined heat and power (CHP) and gas savings from energy efficiency) yields results that can be misleading.

For the ES sector, emission reductions and costs associated with ES-2b, ES-4a, and ES 6a (see Table ExSum-3) were used to estimate the cumulative impacts shown in Table ExSum-2. Note that the row in Table ExSum-2 for the RCI sectors includes only that portion of RCI emissions reductions and net costs (in this case, cost savings) that are from RCI options (or elements of options) that affect fuels that are combusted for purposes other than to generate electricity. RCI emissions reductions and net costs that affect electricity use or generation are included in the ES row in Table ExSum-2, because the benefits and costs of electricity-sector options are dependent on the electrical load served, which is affected by RCI electricity savings. As a result, the net cost savings reported in the ES row in Table ExSum-2, -$5.9 million, is actually the sum of a large estimated net savings from RCI options and a large estimated net cost from ES options.

Table 1-3
Summary of CAPAG's 56 Mitigation Option Recommendations by Sector

Explanatory Note on "Level of Support" column: UC = Unanimous Consent (all CAPAG members attending meeting agree), SMJ = Super Majority (80% or more of the CAPAG members attending meeting agree).

	Mitigation Option Name	GHG Reductions ($MMtCO_2e$)			Net Present Value 2007–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of Support
		2010	2020	Total 2007–2020			
	Residential, Commercial, and Industrial (RCI)						
RCI–1	Demand Side Management Programs for the RCI Sectors - Recommended Case: "Top-Ten States" EE Investment	1.9	11.6	77.1	–1,895	–25	UC
RCI–2	Expand Energy Efficiency Funds	1.5	8.0	54.8	–1,346	–25	UC
RCI–3	Energy Efficiency Requirements for Government Buildings	0.0	1.1	6.4	–88	–14	UC
RCI–4	Market Transformation and Technology Development Programs	0.0	2.0	10.5	–339	–32	UC
RCI–5	Improved Appliance and Equipment Efficiency Standards	0.0	1.0	5.3	–336	–63	UC
RCI–6	Building Energy Codes	0.5	3.5	23.1	–400	–17	UC
RCI–7	"Beyond Code" Building Design Incentives and Targets, Incorporating Local Building Materials and Advanced Construction	0.7	5.2	34.2	–494	–14	UC
RCI–8	Education (Consumer, Primary/Secondary, Post-Secondary/ Specialist, College and University Programs)	Not quantified					UC
RCI–9	Green Power Purchasing (required for state facilities) and Bulk Purchasing Programs for Energy Efficiency or Other Equipment	0.1	0.5	3.5	11	3	UC
RCI–10	Distributed Renewable and Clean Fossil Fuel Power Generation	1.2	4.6	33.5	392	12	UC
RCI–11	Residential, Commercial, and Industrial Energy and Emissions Technical Assistance and Recommended Measure Implementation	0.5	2.1	14.9	–494	–33	UC
	SECTOR TOTAL AFTER ADJUSTING FOR OVERLAPS	5.3	33.0	218.7	–3,994	–18	
	REDUCTIONS FROM RECENT ACTIONS**	0.5	1.2	10.1			
RCI–1	Demand Side Management Programs for the Residential, Commercial and Industrial Sectors	0.3	0.7	6.2			
RCI–2	Expand Energy Efficiency Funds	0.2	0.4	3.6			
RCI–6	Building Energy Codes	0.0	0.0	0.0			
RCI–9	Green Power Purchasing (required for state facilities) and Bulk Purchasing Programs for Energy Efficiency or Other Equipment	0.0	0.0	0.3			
	SECTOR TOTAL PLUS RECENT ACTIONS	5.8	34.2	228.8			

	Mitigation Option Name	GHG Reductions ($MMtCO_2e$)			Net Present Value 2007–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of Support
		2010	2020	Total 2007–2020			
ES-1	Renewable Energy Incentives	0.01	0.04	0.33	15	45.1	UC
ES-2	Environmental Portfolio Standard						
ES-2a	Original Analysis	6.94	44.3	288.7	1,634	5.7	UC
ES-2b	20% Combined Target	5.90	23.4	166.2	409.80	2.5	UC
ES-2c	Load Growth Offset Target	5.53	22.3	160.3	393.95	2.5	UC
ES-3	Removing Barriers to CHP and Clean DG	0.69	2.8	20.1	127.98	6.4	UC
ES-4	CO_2 Tax and/or Cap-and-Trade						
ES-4a	Electric Sector Only	0.84	3.3	20.4	119	5.8	SMJ
ES-4b	Economy-wide	1.84	7.1	47.7	284	6.0	SMJ
ES-5	Legislative Changes to Address Environmental and Other factors	Not quantified					UC
ES-6	Incentives for Advanced Coal						
ES-6a	Replacement of New 800 MW Pulverized Coal Plant	0.00	3.9	31.0	949	30.6	UC
ES-6b	Replacement of Existing 800 MW Pulverized Coal Plant	0.00	5.4	42.9	2,061	48.1	UC
ES-7	Public Benefit Charge	0.8	3.4	24.4	329	13.5	SMJ
ES-8	Waste to Energy	0.0	0.0	0.02	–0.7	–36.8	UC
ES-9	Incentives for CHP and Clean DG	Combined with ES-3					UC
ES-10	NC GreenPower Renewable Resources Program	0.01	0.2	0.95	35	37.0	UC
	SECTOR TOTAL AFTER ADJUSTING FOR OVERLAPS*	6.5	62.7	375	–5.9	–0.016	
	REDUCTIONS FROM RECENT ACTIONS (none)	(	(	(	0	0	
	SECTOR TOTAL PLUS RECENT ACTIONS*	6.5	62.7	375	–5.9	–0.016	

	Mitigation Option Name	GHG Reductions ($MMtCO_2e$)			Net Present Value 2007–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of Support
		2010	2020	Total 2007–2020			
	[redacted]						
TLU-1a	Land Development Planning	2.6	8.0	58.2	Net savings		SMJ
TLU-1b	Multi-Modal Transportation and Promotion (formerly TLU-2)	3.7	5.8	52.4	–1,300	–25	UC
TLU-3a	Surcharges to Raise Revenue	1.2	2.2	15.7	–1,800	–117	SMJ
TLU-3b	Rebates/ Feebates to Change Fleet Mix	0	< 0.5	2.8	Not quantified	–40 to +10	SMJ
TLU-4	Truckstop Electrification	Included in TLU–8			Net savings		UC
TLU-5	Tailpipe GHG Standards	0	8.1	44.5	–1,150	–38	SMJ
TLU-6	Biofuels Bundle	1.9	4.5	35.4	Not quantified		UC
TLU-7	Procure Efficient Fleets	Included in TLU–6					UC
TLU-8	Idle Reduction/Elimination Policies	0.1	0.2	2.2	–6	–4	UC
TLU-9	Diesel Retrofits	0.3	2.2	13.5	Not quantified		UC
TLU-11	Pay-As-You Drive Insurance	2.3	5.3	42.0	Expected net savings		SMJ
TLU-12	Advanced Technology Incentives	Not quantified					UC
TLU-13	Buses – Clean Fuels	Included in TLU–6					UC
	SECTOR TOTAL AFTER ADJUSTING FOR OVERLAPS	11.1	25.5	232.3	–4,350	–19	
	REDUCTIONS FROM RECENT ACTIONS (none)	0	0	0	0	0	
	SECTOR TOTAL PLUS RECENT ACTIONS	11.1	25.5	232.3	–4,350	–19	
AFW-1	Manure Digesters & Energy Utilization	0.2	0.9	6.4	199	32	UC
AFW-2	Biodiesel Production (incentives for feedstocks and production plants)	0.2	0.8	5.1	286	56	UC
AFW-3	Soil Carbon Management (including organic prod. methods incentives)	0.2	0.2	3.0	–16	–5	UC
AFW-4a	Preservation of Working Land–Agricultural Land	0.2	0.3	2.6	290	114	UC
AFW-4b	Preservation of Working Land–Forest Land (formerly AFW-7)	1.7	4.3	36	112	3	UC
AFW-5	Agricultural Biomass Feedstocks for Electricity or Steam Production	0.009	0.02	0.2	10	54	UC
AFW-6	Policies to Promote Ethanol Production	0.9	6.9	38	200	5	UC
AFW-8	Afforestation and/or Restoration of Nonforested Lands	0.2	2.4	15	128	9	UC
AFW-9&10	Expanded Use of Forest Biomass and Better Forest Management	1.5	5.9	48	–639	–13	UC
AFW-11	Landfill Methane and Biogas Energy Programs	1.1	2.9	20	23	1	UC
AFW-12	Increased Recycling Infrastructure and Collection	0.2	0.5	4.1	4	1	UC
AFW-13	Urban Forestry Measures	1.4	4.3	34	–376	–11	UC
	SECTOR TOTAL AFTER ADJUSTING FOR OVERLAPS	7.9	29	213	222	1	
	REDUCTIONS FROM RECENT ACTIONS (none)	0	0	0	0	0	
	SECTOR TOTAL PLUS RECENT ACTIONS	7.9	29	213	222	1	

	Mitigation Option Name	GHG Reductions ($MMtCO_2e$)			Net Present Value 2007–2020 (Million $)	Cost-Effectiveness ($/tCO2e	Level of Support
		2010	2020	Total 2007–2020			
	Cross-Cutting Issues (CC)						
CC-1	GHG Inventories and Forecasts	Not quantified					UC
CC-2	GHG Reporting	Not quantified					UC
CC-3	GHG Registry	Not quantified					UC
CC-4	Public Education and Outreach	Not quantified					UC
CC-5	Adaptation	Not quantified					UC
CC-6	Options for Goals or Targets (for CAPAG in support of LCGCC)	Not quantified					UC

Notes: Negative values in the Net Present Value and the Cost-Effectiveness columns represent net *cost savings* associated with the options.
Some options were renumbered (i.e., AFW-7 to AFW-4b; TLU 2 to TLU-1b) or combined (e.g., AFW 9&10), and others were divided into sections a, b, c to yield a total of 56 options supported by CAPAG.

* For ES-2, ES-4, and ES-6, emission reductions and costs associated with ES-2b, ES-4a, and ES 6a were used to estimate the cumulative impacts shown in Tables ExSum-2 and ExSum-3.

** "Recent actions" represent initiatives undertaken in North Carolina that reduce GHG emissions that were implemented shortly before or during the CAPAG process. The emission reductions associated with recent actions are not accounted for in the GHG emissions inventory and reference case projections. Emissions reductions associated with these recent actions were therefore estimated separately, and are counted toward overall statewide reductions along with reductions from the mitigation options recommended by the CAPAG.

Perspectives on Mitigation Option Recommendations

There can be a large imprecision in the GHG reductions associated with various options. Figure 1-3 presents the estimated tons of reductions for each mitigation option recommendation for which estimates were available, expressed as a cumulative figure for the period 2007-2020.

In addition to the imprecision in GHG reductions achieved by each option, there are also uncertainties in the exact cost (or cost savings) per ton of reduction achieved. Figure 1-4 presents the estimated dollars per ton cost (or cost savings, depicted as a negative number) for each recommended mitigation option, for which cost estimates were available. This measure is calculated by dividing the net present value of the cost of the option by the cumulative GHG reductions, all for the period 2007-2020.

In some cases, there is a wide variation in the cost effectiveness of mitigation options depending on the assumptions used in the analysis. As an example, option TLU-5 (Tailpipe GHG Standards) recommends that North Carolina adopt California GHG emissions standards for light-duty vehicles to reduce GHG emissions (also known as the Pavley standards). California standards require GHG emissions reductions of about 30% from new vehicles, phased in from 2009 to 2016, through a variety of means. The California Air Resources Board (CARB) estimated that the cost of compliance in a new vehicle in model year 2016 would be approximately $1,000. To determine the net impact on consumers, CARB calculated the increase in monthly loan payments versus the savings from reduced fuel consumption. Their net resulting estimate is that consumers

would achieve a net savings, starting at the time of purchase, of approximately $3.50 to $7.00 / month.

In contrast, automobile manufacturers estimate that the California standards would cost around $3,000 per vehicle, and calculated that savings on fuel would offset less than half of that cost for consumers. A review of the literature and assumptions used to derive the different estimates gives a range of cost-effectiveness values of -$38 to -$117 per ton of CO_2e reduced. That is, for each ton reduced, between $38 and $117 would be saved. More than ten other states have adopted the California standards and, among other factors that support the use of a savings estimate toward the higher end of the range, manufacturers should realize economies-of-scale that would lower manufacturing costs as additional states adopt and implement the standards. Although we believe that savings are likely to be higher than the -$38 per ton end of the range, we use a cost-effectiveness of -$38 per ton of CO_2e reduced in our calculations in an effort to be conservative.

Note that this option cannot be implemented until any pending law suits are settled and the US Environmental Protection Agency issues a waiver under the Clean Air Act authorizing California to implement the standards. This may take some months.

Figure 1-3
CAPAG Mitigation Option Recommendations Ranked by Cumulative GHG Reductions, 2007-2020

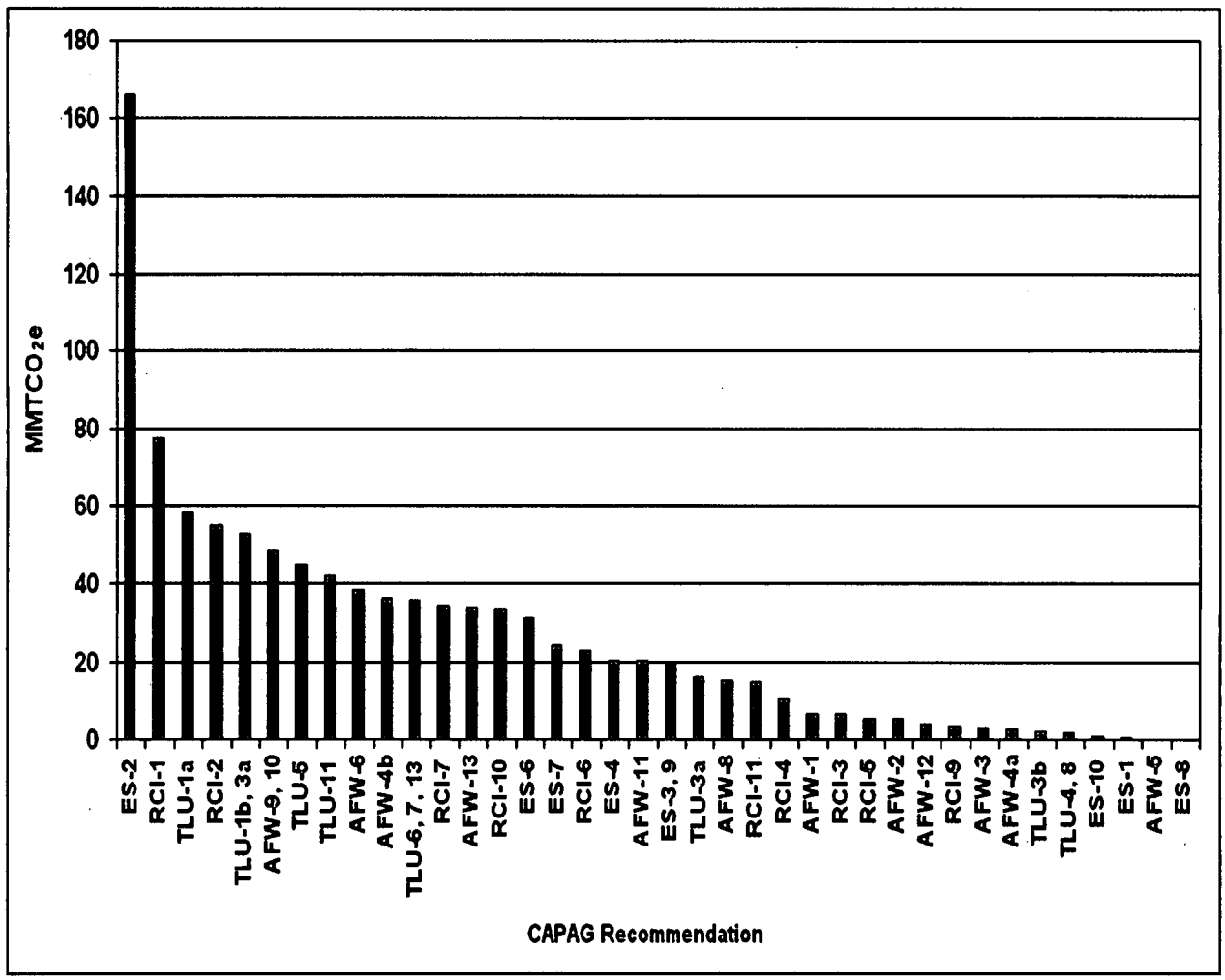
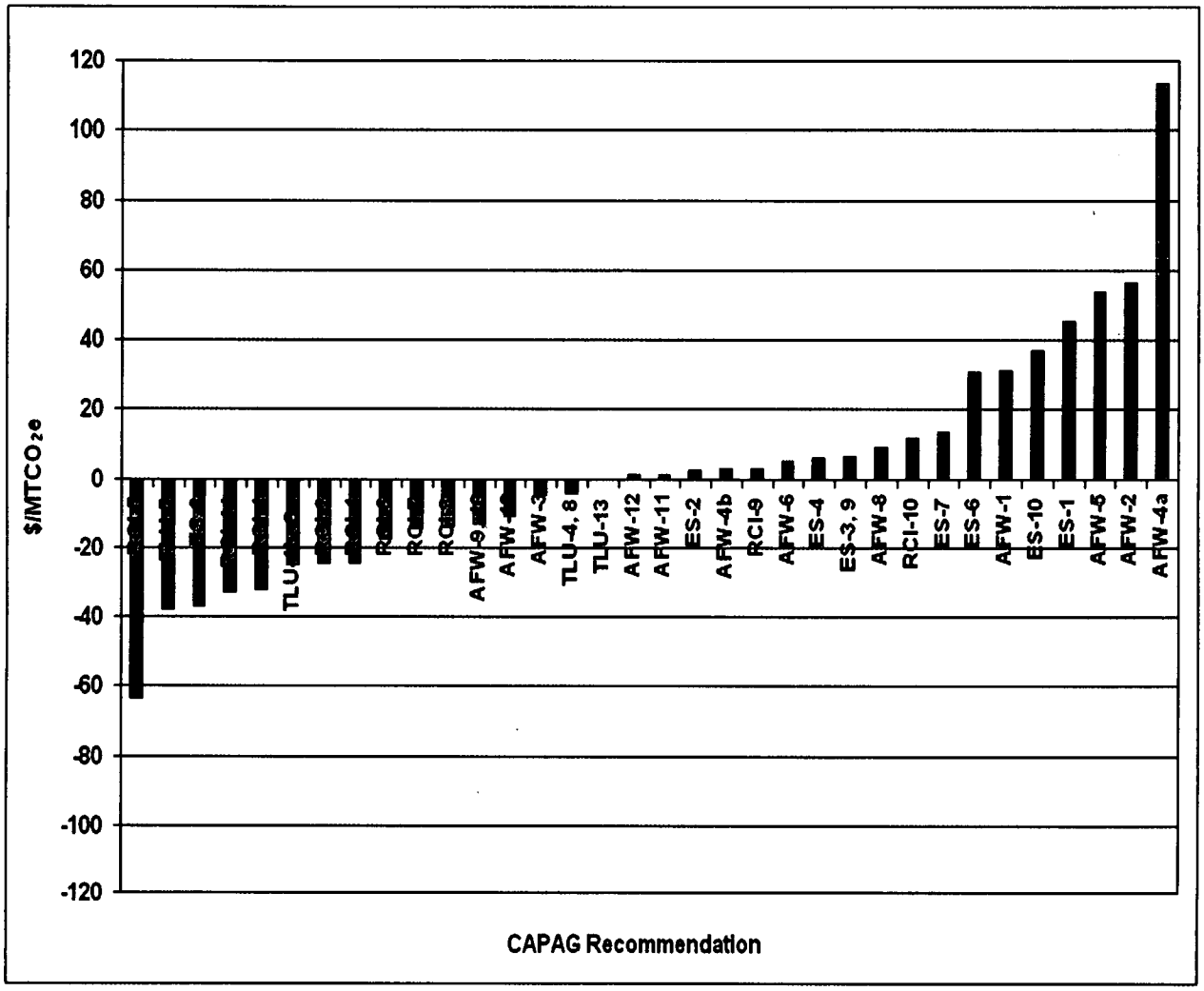


Figure 1-4
CAPAG Mitigation Option Recommendations Ranked by Dollars per Ton



Note: Negative values represent net cost savings and positive values represent net costs associated with the mitigation options.

North Carolina



Climate Action Plan Advisory Group (CAPAG)

Recommended Mitigation Options for Controlling Greenhouse Gas Emissions



Draft FINAL Report October 2007

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Preface

This report contains recommendations from a voluntary stakeholder advisory group on potential measures to reduce greenhouse gas (GHG) emissions that are worthy of consideration by policy makers in North Carolina. This advisory group represents a broad range of interests in North Carolina. This advisory group, named The Climate Action Plan Advisory Group (CAPAG) consists of over 40 volunteers from business, industry, environmental groups, academia, government and the general public. A consultant, the Center for Climate Strategies (CCS), provided facilitation and technical analysis expertise. From over 300 potential GHG mitigation options, more than 50 were analyzed considering likely GHG reductions, costs and benefits.

Benefit analysis included potential for jobs creation in North Carolina as new measures and technologies are employed. This analysis was conducted in addition to the CAPAG specific work by Appalachian State University and these data and results are presented in this report. [To be added when completed between October and December 2007]

The North Carolina General Assembly created a Legislative Commission on Global Climate Change (LCGCC) in the fall of 2005 to address climate related issues. These included whether North Carolina should set a goal for reduction of GHGs in this state, and if so, what should that goal be. CAPAG coordinated closely with the LCGCC and shared several members with that Commission.

This report is not intended to be a climate action implementation plan for North Carolina. Such a plan will come only after State policy makers assess these and other recommendations further. However the data, results and recommendations contained in this report provide valuable guidance for the creation of an action plan or plans for legislative, administrative, regulatory or voluntary action in this state.

Acknowledgments

The North Carolina Climate Action Plan Advisory Group (CAPAG) gratefully acknowledges the following individuals and organizations who contributed significantly to the successful completion of the CAPAG process and the publication of this Final Report:

Thomas D. Peterson and the Center for Climate Strategies (CCS), with its dedicated team of professionals that contributed extraordinary amounts of time, energy, and expertise in providing facilitation services and technical analysis for the CAPAG process. Special thanks to June Taylor, Laurie Cullen, and Randy Strait who coordinated and edited the Final Report, and to other CCS team members:

Alison Bailie
Kenneth Colburn
Bill Dougherty
Karl Hausker
Sivan Kartha
Lewison Lem
Stephen Roe
Will Schroeer
David Von Hippel

Special thanks also go to Brock Nicholson and James Southerland of the North Carolina (NC) Department of Environment and Natural Resources' (DENR) Division of Air Quality (DAQ) who coordinated and supervised all activities associated with the CAPAG process on behalf of DENR/DAQ. Many thanks also to DENR staff Charles Davis, Kimberly Garnett, Heather Hawkins, and Phyllis Jones who also contributed their time, energy, and expertise as DENR/DAQ's liaisons to the Technical Work Groups.

The CAPAG also recognizes the many individuals who participated in the sector-based Technical Work Groups, all of whom are listed in Appendix B. Even though this report is intended to represent the results of the CAPAG's work, the group would be remiss if it did not recognize and express appreciation for the time and efforts spent in discussion, study, and deliberation of each fellow member of the group.

Finally, the CAPAG would like thank the donor organizations that provided the financial support to CCS that allowed it to serve the CAPAG: NC DENR, Energy Foundation, Rockefeller Brothers Fund, Surdna Foundation, and Z. Smith Reynolds Foundation.

Members of the North Carolina Climate Action Plan Advisory Group[1]

Stan Adams, NC DENR, Division of Forestry Resources (now retired, but active)
Dan Besse, Winston-Salem City Council
Ryan Boyles, State Climatologist, NC Climate Office (original member was Sethu Raman – now retired)
Thomas F. Cecich, Environmental Management Commission
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Stephen Whitfield, NC Woodlands
Jim Witkowski, International Paper (replaced Edward Kruel)
Skip Yeakel, Volvo Trucks North America

[1] Note: A limited number of members of the CAPAG were members in the beginning, but due to job changes, etc. were later replaced by others – representing the same company. Their participation and contributions are acknowledged and appreciated even though they were not on the Group for its full existence.

Acronyms

AEO	Annual Energy Outlook
AFW	Agriculture, Forestry, and Waste Management [TWG]
AQ	air quality
AVL	automatic vehicle location
BCAP	Building Code Assistance Project
C&D	construction & demolition
CALS	College of Agriculture and Life Sciences [NCSU]
CAPAG	[North Carolina] Climate Action Plan Advisory Group
CARB	California Air Resources Board
CC	Cross-Cutting Issues [TWG]
CCS	Center for Climate Strategies
CCSR	carbon capture and sequestration or reuse
CEFS	Center for Environmental Farming Systems [North Carolina Department of Agriculture and Consumer Services]
CH_4	methane
CHP	combined heat and power
CHP	combined heating, cooling, and power
CNG	compressed natural gas
CNR	College of Natural Resources [NCSU]
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CREP	Conservation Reserve Enhancement Program [USDA]
CRP	Conservation Reserve Program [USDA]
CS	Cambridge Systematics, Inc.
CSA	Clean Smokestacks Act [of 2002]
DAQ	[North Carolina] Division of Air Quality
DCM	[North Carolina] Division of Coastal Management
DENR	[North Carolina] Department of Environment and Natural Resources
DG	distributed generation
DMV	[NCDOT] Division of Motor Vehicles
DOC	diesel oxidation catalyst
DOR	[North Carolina] Department of Revenue
DPPEA	[North Carolina] Division of Pollution Prevention and Environmental Assistance
DSM	demand-side management
EIA	Energy Information Administration [US DOE]

EMC	Environmental Management Commission
EPS	environmental portfolio standard
EQIP	Environmental Quality Incentives Program [USDA]
ERC	Environmental Review Commission
ES	Energy Supply [TWG]
ESI	Environmental Stewardship Initiative
FDP	[North Carolina] Forest Development Program
FERC	Federal Energy Regulatory Commission
FFV	flexible fuel vehicle
FIA	Forest Inventory Analysis
FPP	Farm Preservation Program
FSA	Farm Service Agency [USDA]
GHG	greenhouse gas
GMAC	General Motors Acceptance Corporation
GPS	global positioning systems
GWh	gigawatts per hour
HBH	HealthyBuilt Homes [Program]
HDV	heavy-duty vehicle
HFC	hydrofluorocarbon
HVAC	heating, ventilation, and air conditioning
HWP	harvested wood products
IECC	International Energy Conservation Code
IGCC	integrated gasification combined cycle
IR/E	idle reduction/elimination
IT	information technology
kWh	kilowatts per hour
LCGCC	[North Carolina] Legislative Commission on Global Climate Change
LCID	land clearing and inert debris [landfills]
LDV	light-duty vehicle
LEED	Leadership in Energy and Environmental Design
LFG	landfill gas
LFGTE	landfill gas to energy
LPG	liquefied petroleum gas
MMt	million metric tons
$MMtCO_2e$	million metric tons of carbon dioxide equivalent
MST	municipal sewage treatment
MSW	municipal solid waste
MT	metric tons

MW	megawatt
N_2O	nitrous oxide
NC DFR	North Carolina [DENR] Division of Forest Resources
NCA&T	North Carolina Agricultural & Technical State University
NCCES	North Carolina Cooperative Extension Service
NCDA&CS	North Carolina Department of Agriculture and Consumer Services
NCDOT	North Carolina Department of Transportation
NCHFA	North Carolina Housing Finance Agency
NCSTEP	North Carolina Small Town Economic Development
NCSU	North Carolina State University
NEMS	National Energy Modeling System
NESCAUM	Northeast States for Coordinated Air Use Management
NO_x	oxides of nitrogen
NPV	net present value
NRCS	[USDA] Natural Resource Conservation Service
PAYD	Pay-As-You-Drive
PBF	Public Benefits Fund
PC	performance-based contracting
PFC	perfluorocarbon
PIRG	Public Research Interest Group
PM	particulate matter
PSCNC	[Scana] Public Service Company North Carolina
PTD	[NCDOT] Public Transportation Division
PV	photovoltaic
R&D	research and development
RCI	Residential, Commercial, and Industrial [TWG]
REC	renewable energy credits
RFF	Resources for the Future
RFS	renewable fuel standard
ROI	return on investment
RPS	renewable portfolio standard
RTD	Regional Transportation District [bus rapid transit]
SEO	State Energy Office
SEP	State Energy Plan
SERC	Southeastern Electric Reliability Council
SF_6	sulfur hexafluoride
SGIT	State Greenhouse Gas Inventory Tool [USEPA]
SMEs	small and medium enterprises

SO_2	sulfur dioxide
SOV	single-occupancy vehicle
SWCD	[North Carolina] Soil and Water Conservation District
SWH	solar water heating
T&D	transmission and distribution
TDM	Transportation Demand Management Program
TLU	Transportation and Land Use [TWG]
TMO	Transportation Management Organization
TSE	truck stop electrification
TWG	Technical Work Group
USFS	US Forest Service
USI	Utility Savings Initiative
VMT	vehicle miles traveled
WARM	WAste Reduction Model [USEPA]
WHIP	Wildlife Habitat Incentives Program [USDA]
WRP	Waste Reduction Partners

Chapter 2
Inventory and Projections of GHG Emissions

Introduction

This chapter presents a summary of North Carolina's anthropogenic greenhouse gas (GHG) emissions and sinks (carbon storage) from 1990 to 2020. The Center for Climate Strategies (CCS) prepared a preliminary draft of North Carolina's GHG emissions and reference case projections under contract to the North Carolina Department of Environment and Natural Resources' (DENR) Division of Air Quality (DAQ).[1] The preliminary draft inventory and reference case projections, completed in February 2006, provided DENR/DAQ with an initial, comprehensive understanding of current and possible future GHG emissions. The preliminary draft report was provided to the North Carolina Climate Action Plan Advisory Group (CAPAG) (and its Technical Work Groups (TWGs)) to assist the CAPAG in understanding past, current, and possible future GHG emissions in North Carolina, and thereby inform the mitigation option development process. The CAPAG and the TWGs also provided comments for improving the reference case projections. Subsequently, the inventory and reference case projection estimates were revised to incorporate revisions approved by the CAPAG. The information presented in this chapter reflects the information presented in the final inventory and reference case projections report (hereafter referred to as the *Inventory and Projections).*[2]

Historical GHG emissions estimates (1990 through 2005)[3] were developed using a set of generally accepted principles and guidelines for State GHG emissions, relying to the extent possible on North Carolina-specific data and inputs. The initial reference case projections (2006-2020) are based on a compilation of various existing North Carolina projections of electricity generation, fuel use, and other GHG-emitting activities, along with a set of simple, transparent assumptions described in the appendices of the *Inventory and Projections* report.

The *Inventory and Projections* covers the six types of gases included in the US Greenhouse Gas Inventory: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). Emissions of these GHGs are presented using a common metric, CO_2 equivalence (CO_2e), which indicates the relative contribution of each gas, per unit mass, to global average radiative forcing on a global warming potential- (GWP-) weighted basis.

It is important to note that the emissions estimates reflect the *GHG emissions associated with the electricity sources used to meet North Carolina's demands,* corresponding to a consumption-based approach to emissions accounting. Another way to look at electricity emissions is to consider the *GHG emissions produced by electricity generation facilities in the State.* This report

[1] *Revised Draft North Carolina Greenhouse Gas Inventory and Reference Case Projections, 1990-2020,* prepared by the Center for Climate Strategies for the North Carolina DENR/DAQ, February 2006.

[2] *Final North Carolina Greenhouse Gas Inventory and Reference Case Projections, 1990-2020,* prepared by the Center for Climate Strategies for the North Carolina DENR/DAQ, September 2007.

[3] The last year of available historical data varies by sector; ranging from 2000 to 2004.

covers both methods of accounting for emissions, but for consistency, all total results are reported as *consumption-based.*

North Carolina Greenhouse Gas Emissions: Sources and Trends

Table 2-1 provides a summary of GHG emissions estimated for North Carolina by sector for the years 1990, 2000, 2005, 2010, and 2020. As shown in this table, North Carolina is estimated to be a net source of GHG emissions, but with sinks of GHG emissions due to the forestry sector. We note that there are significant uncertainties associated with estimating forest carbon sinks. In the sections below, we discuss GHG emission sources (positive, or *gross*, emissions) and sinks (negative emissions) separately in order to identify trends, projections and uncertainties clearly.

This next section of the report provides a summary of the historical emissions (1990 through 2005) followed by a summary of the forecasted reference case projection year emissions (2006 through 2020), and then by a description of key uncertainties.

Table 2-1
North Carolina Historical and Reference Case GHG Emissions, by Sector[a]

(Million Metric tons CO_2e)	1990	2000	2005	2010	2020
Energy	**121**	**160**	**167**	**187**	**218**
Electricity Use (Consumption)	53.8	75.4	75.8	85.8	98.4
Transportation Fuel Use	39.7	52.7	59.4	66.4	81.5
Res/Comm/Other Ind. Fuel Use	27.3	30.9	31.8	34.5	38.5
Other	**14.8**	**21.1**	**25.2**	**27.7**	**37.2**
Industrial Processes	1.6	3.1	5.4	7.1	15.1
Agriculture	8.3	11.0	13.3	14.1	15.5
Waste Management	4.8	7.0	6.5	6.5	6.6
Gross Emissions (Consumption Basis)	**136**	**180**	**192**	**214**	**256**
change relative to 1990		*33%*	*42%*	*58%*	*88%*
change relative to 2000			*7%*	*19%*	*42%*
Forestry	**-23.2**	**-23.7**	**-23.7**	**-23.7**	**-23.7**
Net Emissions (Consumption Basis, Including Forest Sink)	**112**	**156**	**169**	**191**	**232**
change relative to 1990		*39%*	*50%*	*70%*	*106%*
change relative to 2000			*8%*	*22%*	*48%*
Per Capita Gross Emissions	**20.5**	**22.4**	**22.1**	**22.7**	**23.4**

[a] Totals may not equal exact sum of subtotals shown in this table due to independent rounding.

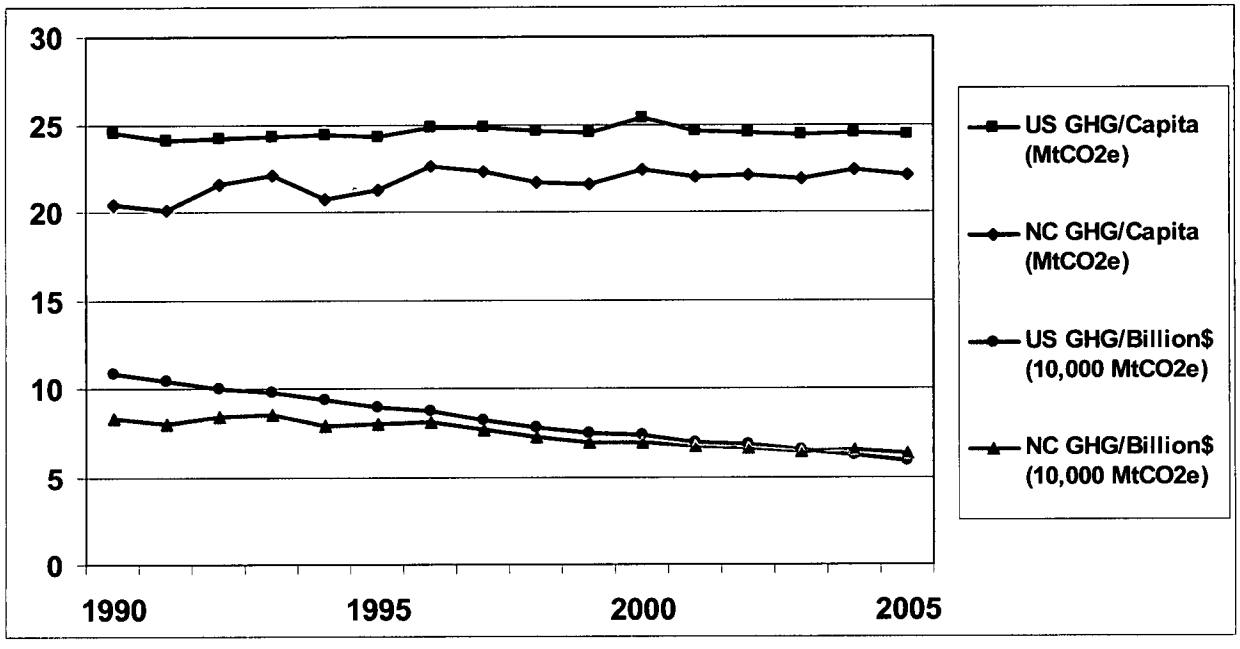
Historical Emissions

Overview

In 2000, on a gross emissions consumption basis (i.e., excluding carbon sinks), North Carolina accounted for approximately 180 million metric tons (MMt) of carbon dioxide equivalent (CO_2e) emissions, an amount equal to 2.5% of total Untied States (US) gross GHG emissions. On a net emissions basis (i.e., including carbon sinks), North Carolina accounted for approximately 156 $MMtCO_2e$ of emissions in 2000, an amount equal to 2.4% of total US net GHG emissions.[4] North Carolina's GHG emissions are rising more quickly than the nation as a whole. From 1990 to 2000, North Carolina's gross and net GHG emissions were up 33% while national gross emissions rose by 16% during this period.[5]

On a per capita basis, North Carolinians emitted about 22 metric tons (Mt) of gross CO_2e in 2000, less than the national average of about 25 $MtCO_2e$. Figure 2-1 illustrates the State's emissions per capita and per unit of economic output. It also shows that like the nation as a whole, per capita emissions have remained fairly flat, while economic growth exceeded emissions growth throughout the 1990-2002 period. From 1990 to 2000, emissions per unit of gross product dropped by 32% nationally, and by 17% in North Carolina.[6]

Figure 2-1
North Carolina and US GHG Emissions, Per Capita and Per Unit Gross Product



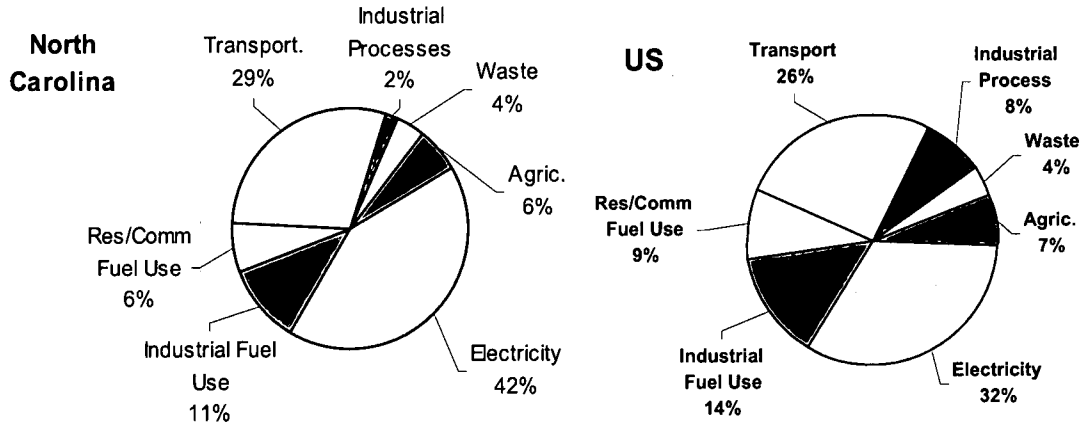
[4] National emissions from *Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2005*, April 2007, US EPA #430-R-07-002, (http://www.epa.gov/climatechange/emissions/usinventoryreport.html).

[5] During the 1990s, population grew by 21% in North Carolina compared with 13% nationally. Furthermore, North Carolina's economy grew faster on a per capita basis (up 60% vs. 52% nationally).

[6] Based on gross domestic product by state (millions of current dollars), available from the US Bureau of Economic Analysis (http://www.bea.gov/regional/gsp/).

The principal sources of North Carolina's GHG emissions are electricity use (including electricity imports in 2000) and transportation, accounting for 42% and 29% of North Carolina's *gross* GHG emissions, respectively, as shown in Figure 2-2.[7] The remaining use of fossil fuels – natural gas, oil products, and coal -- in the residential, commercial, and industrial (RCI) sectors constitute another 17% of State emissions.

Figure 2-2
Gross GHG Emissions by Sector, 2000, North Carolina and US



Agricultural activities such as manure management, fertilizer use, and livestock (enteric fermentation) result in CH_4 and N_2O emissions that account for another 6% of State GHG emissions. Industrial process emissions comprise about 2% of State GHG emissions in 2000, and these emissions are rising rapidly due to the increasing use of HFCs and PFCs as substitutes for ozone-depleting chlorofluorocarbons.[8] Other industrial processes emissions result from aluminum manufacturing; PFC use in semiconductor manufacture; CO_2 released during soda ash, limestone, and dolomite use; and SF_6 released from transformers used in electricity transmission and distribution systems. Landfills and wastewater management facilities produce CH_4 and N_2O emissions accounting for the remaining 4% of the State's gross GHG emissions in 2000.

A Closer Look at the Two Major Sources: Electricity and Transportation

As shown in Figure 2-2, electricity use in 2000 accounted for 42% of North Carolina's gross GHG emissions (about 75 $MMtCO_2e$), which is higher than the national share of emissions from electricity production (32%). On a per capita basis, North Carolina's GHG emissions from electricity consumption are higher than the national average (in 2000, 9.4 $MMtCO_2e$/capita vs. 8.1 $MMtCO_2e$/capita nationally). The average North Carolinian used more electricity than the average US resident (15,000 kilowatt-hours (kWh) per person per year compared to 12,000 kWh nationally in 2000). During the 1990s, electricity demand grew at a rate of 2.9% per year, while electricity emissions grew 3.4% annually, reflecting an increase in emissions per kWh.

[7] *Gross* emissions estimates only include those sources with positive emissions. Carbon sequestration in soils and vegetation is included in *net* emissions estimates.

[8] Chlorofluorocarbons (CFCs) are also potent GHGs; however they are not included in GHG estimates because of concerns related to implementation of the Montreal Protocol. See Appendix I in the *Inventory and Projections* report for North Carolina.

As noted above, these electricity emissions estimates reflect the *GHG emissions associated with the electricity sources used to meet North Carolina demands,* corresponding to a consumption-based approach to emissions accounting. For many years, North Carolina power plants have tended to produce less electricity than is consumed in the State – in the year 2000, for example, North Carolina imported 8% of the electricity consumed in the State. As a result, in 2000, emissions associated with electricity consumption (75 $MMtCO_2e$) were higher than those associated with electricity production (70 $MMtCO_2e$).[9]

While we estimate both the emissions from electricity production and consumption, unless otherwise indicated, tables, figures, and totals in this report reflect electricity consumption emissions. The consumption-based approach can better reflect the emissions (and emissions reductions) associated with activities occurring in the State, particularly with respect to electricity use (and efficiency improvements), and is particularly useful for decision-making. Under this approach, emissions associated with electricity exported to other States would need to be covered in those States' accounts in order to avoid double counting or exclusions.

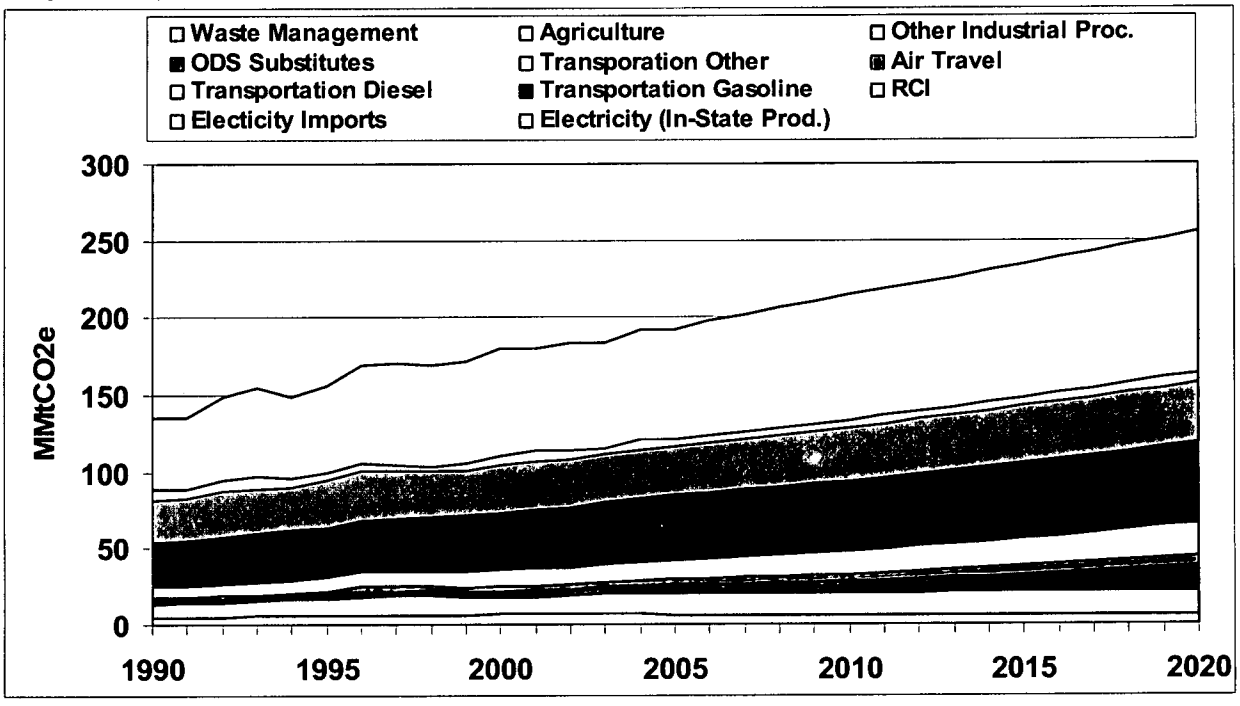
Like electricity emissions, GHG emissions from transportation fuel use have risen steadily from 1990 to 2005 at an average rate of 2.7% annually. Gasoline-powered vehicles account for about 72% of transportation GHG emissions in 2000. Diesel vehicles account for another 21% in 2000; air travel for roughly 6%, and the remainder of transportation emissions come from and natural gas and liquefied petroleum gas (LPG) vehicles. As the result of North Carolina's rapid expansion and an increase in miles traveled during the 1990s, gasoline use has grown at rate of 2.5% annually. Meanwhile, diesel use has risen 4.8% annually, suggesting an even more rapid growth in freight movement within the State.

Reference Case Projections

Relying on North Carolina agency projections of electricity and fuel use, and other assumptions noted in the *Inventory and Projections* report, a simple reference case projection of GHG emissions through 2020 was developed. As illustrated in Figure 2-3 and shown numerically in Table 2-1, under the reference case projections, North Carolina's gross GHG emissions continue to grow steeply, climbing to 256 $MMtCO_2e$ by 2020, 88% above 1990 levels. Electricity is projected to be the largest contributor to future emission growth by far, followed by HFCs and PFCs used in place of ozone-depleting substances (ODS), as shown in Figure 2-4. Other major sources of emissions growth include transport (diesel), gasoline, and fuel use in buildings and industry (RCI). For the electricity supply sector, the increase in emissions after 2010 appears largely as the result of emissions associated with the use of natural gas used to generate electricity by facilities in-state and emissions associated with electricity imported into North Carolina to meet North Carolina's demand for electricity (see Figure 2-5). After 2010, the use of coal and oil to generate electricity in-state is projected to remain at 2010 levels.

[9] Estimating the emissions associated with electricity use requires an understanding of the electricity sources (both in-state and out-of-state) used by utilities to meet consumer demand. The current estimate reflects some very simple assumptions described in Appendix A of *Inventory and Projections*.

Figure 2-3
North Carolina Gross GHG Emissions by Sector, 1990-2020: Historical and Projected (Consumption-based Approach) Business as Usual/Base Case



Overall, the average annual projected rate of emissions growth in North Carolina is 1.8% per year from the year 2000 to 2020. The increase in emissions after 2010 appears largely as the result of four factors: 1) electricity consumption (including imports) growth at a rate faster than population growth, 2) increasing use of vehicles with vehicle-miles traveled (VMT) growing faster than population, 3) freight traffic growing faster than population, and 4) increasing use of HFCs and PFCs as substitutes for ODS in refrigeration, air conditioning, and other applications. Other sources that are projected to grow faster than population are residential natural gas use, industrial fuel use, gasoline, air travel, and agriculture. Figure 2-6 illustrates how growth in net GHG emissions compares to growth in population and gross state product (GSP) for North Carolina.

Figure 2-4
Sector Contributions to Emissions Growth in North Carolina, 1990-2020: Reference Case Projections

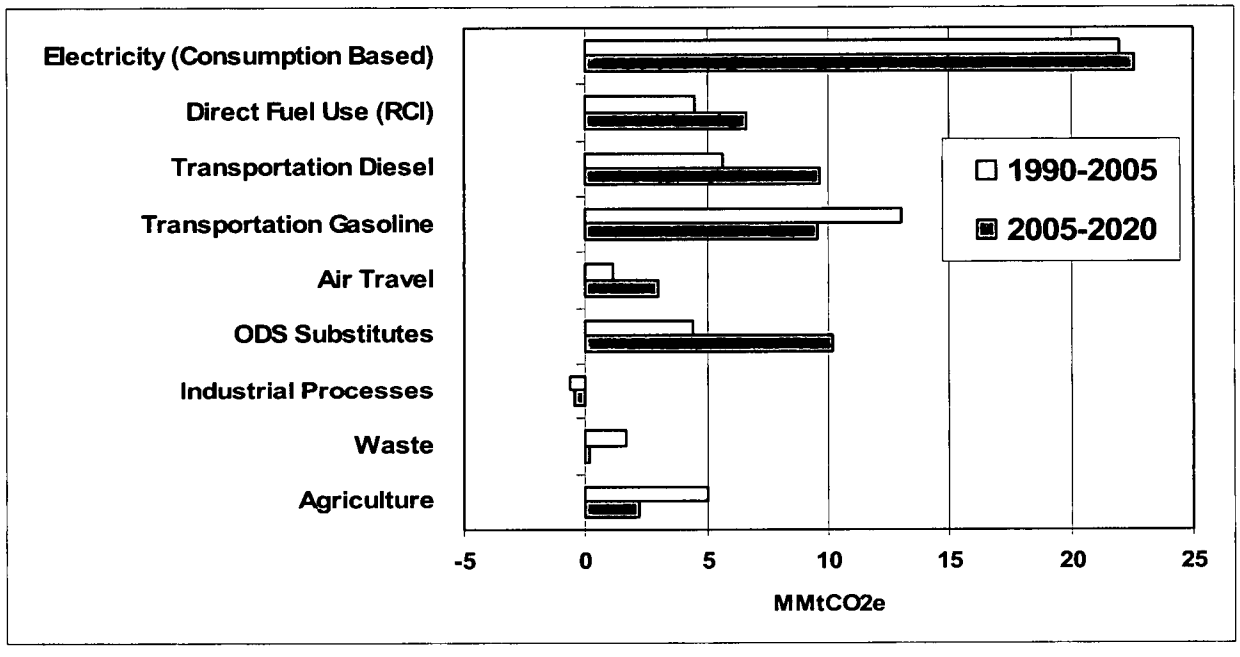
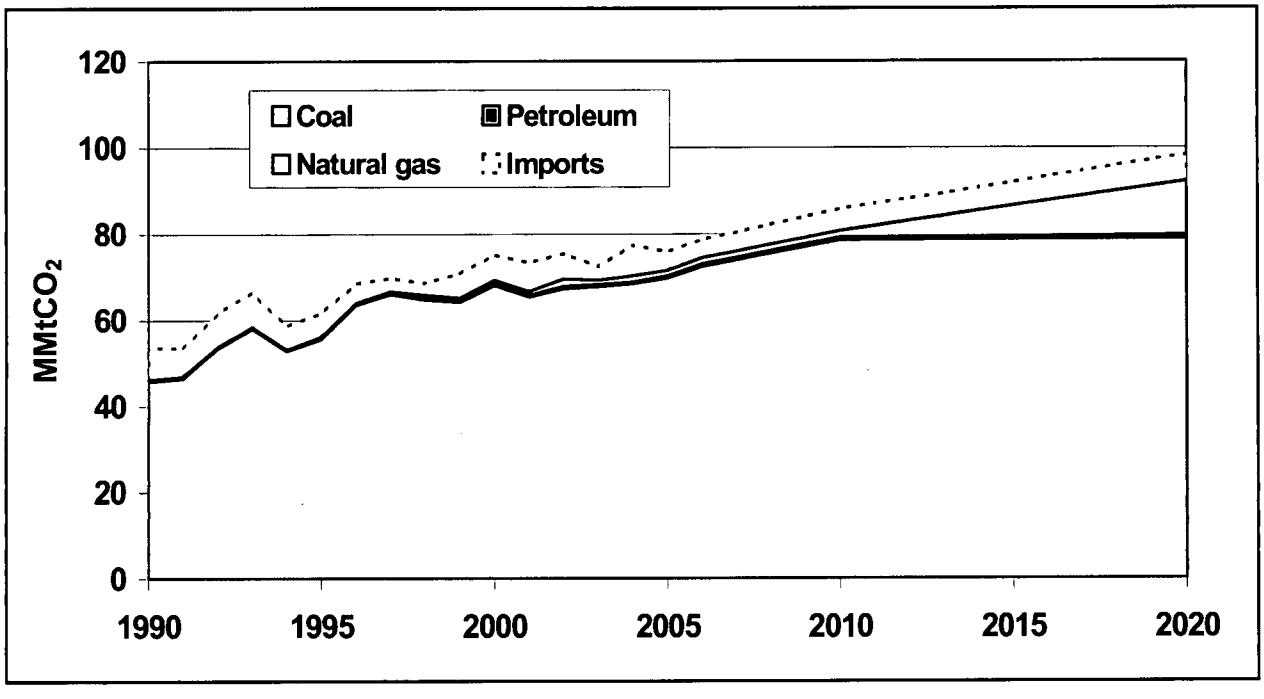
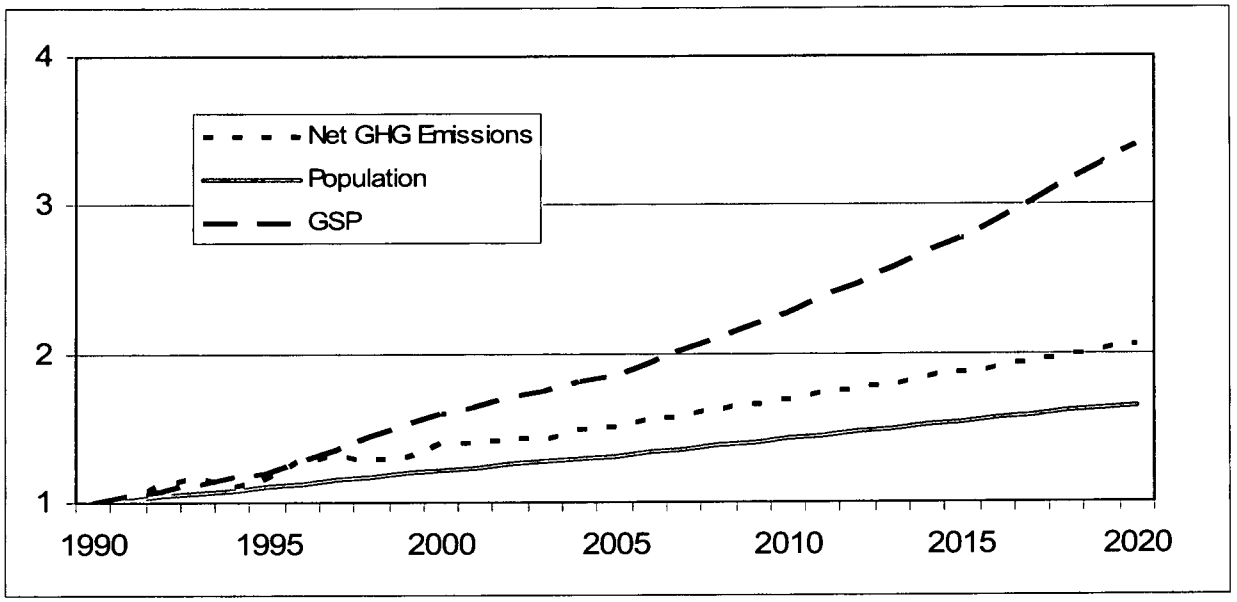


Figure 2-5
Emissions from Electricity Consumption in North Carolina, by Fuel Source



Note: Emissions associated with electricity generated from biomass are not shown in this graph because of scale effects. Emissions associated with biomass combustion are estimated to be about 0.03 $MMtCO_2e$ from 2003 through 2020.

Figure 2-6
North Carolina Historical and Projected Net GHG Emissions, Gross State Product, and Population (Indexed to 1990 Value, measured in $MMTCO_2e$)



CAPAG Revisions

As a result of the CAPAG's and TWGs' review of the draft inventory and reference case projections, the CAPAG approved the following revisions:

Energy Supply for 2003 through 2020: The Energy Supply TWG reviewed the inventory and forecast for the electricity supply sector and identified areas for improving the forecast for North Carolina. The CAPAG approved of the revisions recommended by the TWG. The revisions improved the forecast of emissions for 2003 through 2020 associated with both in-state production and electricity imports. The revisions were to the fuel mix assumptions as well as assumptions on transmission and distribution losses.

Industrial Fuel Use for 1990 through 2020: When the first draft of the inventory and reference case projections was prepared, the EPA's tool for preparing emissions for 1990 through 2002 included independent power producers connected to the power grid. Emissions associated independent power producers were thus included in the industrial subsector for RCI . This category was also included in the energy supply sector in the first draft, following EIA convention for defining sectors. In order to avoid potential double-counting, the inventory and reference case projections were revised such that emissions associated with independent power producers were reported only with the energy supply sector, not with the industrial subsector for RCI. The EPA subsequently revised their tool for the RCI sectors to remove independent power producers.

Table 2-2 shows the change in emissions representing the difference between the revised emissions minus the draft emissions. Overall, the revisions approved by the CAPAG lowered

1990 emissions by 2.9 $MMtCO_2e$, 2005 and 2010 emissions by 3.9 $MMtCO_2e$, and 2020 emissions by 11.4 $MMtCO_2e$.

Table 2-2. Revisions to Inventory and Reference Case Projections ($MMtCO_2e$)

Sector	1990	2000	2005	2010	2020
Electricity Supply - In-State Production	0.0	0.0	-0.2	0.6	-5.3
Electricity Supply - Imports	0.0	0.0	0.3	0.3	-0.1
Industrial Fuel Use	-2.9	-3.4	-4.0	-4.8	-5.9
Total Change from Draft Inventory and Reference Case Projections	-2.9	-3.4	-3.9	-3.9	-11.4

Industrial Processes Non-Fuel Use: The CAPAG and RCI TWG added text to the discussion for this category in the final inventory and reference case projections report noting that, following international and national protocols, the GHG emissions associated with the use of ODS are excluded from GHG inventories.

Key Uncertainties

Some data gaps exist in this inventory, including 1990-1999 activity data for natural gas distribution and transmission. Key tasks, among others, include developing a better understanding of the electricity generation sources currently used to meet North Carolina loads (in collaboration with State utilities), and review and revision of key drivers such as the electricity and transportation fuel use growth rates that will be major determinants of North Carolina's future GHG emissions. Table 2-3 shows the key historical and projected growth rates affecting the North Carolina GHG emissions.

Perhaps the variable with the most important implications for GHG emissions is the type, size, and number of power plants built in North Carolina between now and 2020. There are also significant impacts associated with projecting electricity consumption in the State, as well as in the estimation of consumption-based electricity emissions (i.e., which electricity sources serve North Carolina loads). If a consumption-based emissions approach is adopted by the State, further analysis should be directed towards resources that utilities use to meet North Carolina loads, and methods that can be reliably used to track them.

Emissions of aerosols, particularly black carbon from fossil fuel combustion, could have significant impacts in terms of radiative forcing (i.e., climate impacts). Methodologies for conversion of black carbon mass estimates and projections to global warming potential involve significant uncertainty at present, but CCS has developed and used a recommended approach for estimating black carbon emissions based on methods used in other States. At this time no estimates have been developed for North Carolina. By including black carbon emission estimates in the inventory, additional opportunities for reducing climate impacts are realized.

Table 2-3
Key Annual Growth Rates for North Carolina, Historical and Projected

	1990-2000	2000-2020	Sources/Uses
Population	2.0%	1.5%	North Carolina Office of State Budget and Management
Gross State Product	4.8%	3.9%	*North Carolina Energy Outlook 2003* (not used for projections)
Employment	2.6%	1.3%	*North Carolina Energy Outlook 2003*
Electricity Sales	2.9%	1.5%	US DOE Energy Information Administration (EIA) State Energy Data (SED) for historic, Annual Report of the North Carolina Utilities Commission for Projections
Vehicle Miles Traveled	n/a	2.4%	Federal Highway's Highway Performance Monitoring System (HPMS) and North Carolina DENR

Chapter 3
Residential, Commercial, and Industrial Sectors

Overview of Greenhouse Gas Emissions

The residential, commercial, and industrial (RCI) sectors are directly responsible for almost one-fifth of North Carolina's current gross greenhouse gas (GHG) emissions (37 million metric tons (MMt) of carbon dioxide equivalent (CO_2e) in 2005). Direct emissions of GHGs from the RCI sectors result principally from the on-site combustion of natural gas, oil, and coal plus non-energy sources of GHG emissions – primarily leaks of methane from natural gas transmission and distribution pipelines, the release of CO_2 and fluorinated gases (PFCs) during industrial processing (largely from the aluminum production, soda ash consumption, and semi-conductor industries), the use of sulfur hexafluoride (SF_6) in the utility industry, and the leakage of hydrofluorocarbons (HFCs) from refrigeration and related equipment.[1]

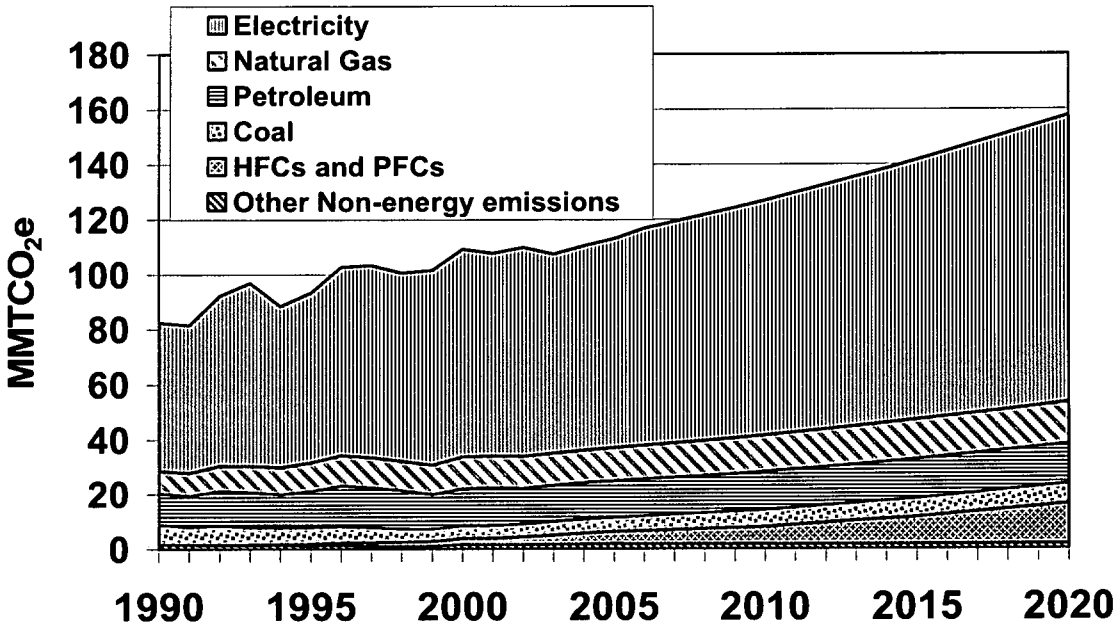
Considering only the direct emissions that occur within buildings and industries, however, ignores the fact that virtually all electricity sold in North Carolina is consumed as the result of activities in the residential, commercial, and industrial sectors. If the emissions associated with producing the electricity consumed in North Carolina are considered, RCI activities are associated with well over half (about 60% of the state's gross GHG emissions.[2] The State's future GHG emissions therefore will depend heavily on future trends in the consumption of electricity and other fuels in the RCI sectors.

Figure 3-1 shows historical and projected RCI GHG emissions by fuel and source, and illustrates the large fraction of RCI emissions associated with electricity use. RCI emissions associated with electricity and natural gas use are expected to rise by nearly 30% between 2005 and 2020, and are projected to account for over 40% of the State's growth in gross GHG emissions during this period.

[1] RCI direct fuel use accounted for 31.8 $MMtCO_2e$ in GHG emissions in 2005, while industrial process emissions accounted for emissions totaling 5.4 $MMtCO_2e$.

[2] Gross emissions here denote greenhouse gas emissions from activities in North Carolina, adjusted for exports of electricity, but not including consideration of estimated "sinks" of greenhouse gases in the forestry and land-use sectors.

Figure 3-1. Historical and projected RCI GHG emissions by fuel and process in North Carolina, 1990 to 2020



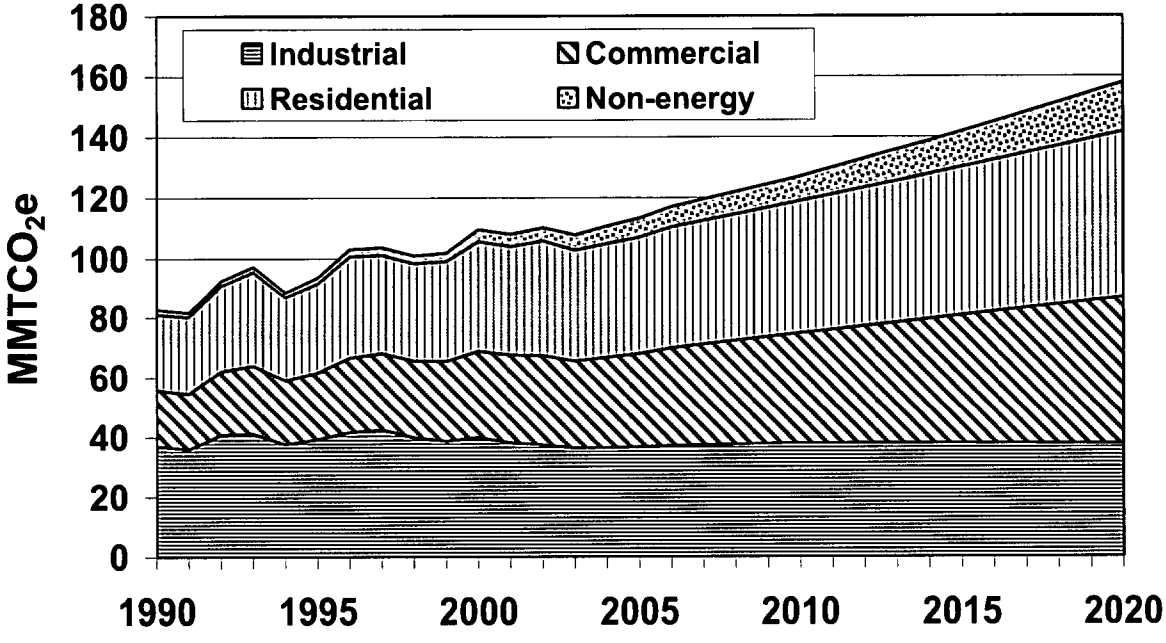
PFCs = perfluorocarbons; HFCs = hydrofluorocarbons.

Since 1990, overall GHG emissions associated with energy consumption in the residential and commercial sectors have grown steadily. This growth is projected to continue, driven by both population growth and increasing commercial activity (as indicated in Figure 3-2). The total emissions from electricity and fuels consumption in the industrial sector have varied, showing increases or and decreases year-to-year, in the years since 1990, but show only a very slight overall reduction from 1990 to 2005[3]. The GHG emissions from industrial sector electricity and fuels use are expected to grow modestly through 2010, and decline slightly thereafter, so that 2020 emissions are projected to be about 2.5% higher than emissions in 2005. Non-energy emissions grew by a factor of more than 3 between 1990 and 2005, largely as a result of increased emissions from HFC use. This trend in non-energy emissions is expected to accelerate in the future. Non-energy emissions are projected to increase by over 8% per year from 2005 to 2020 – increasing from 2% of total gross GHG emissions in 2000 to almost 6% in 2020. Increased use of HFCs for refrigeration, air conditioning and other uses, as substitutes for ozone depleting substances, are the main source of the projected emissions increases. Even low amounts of HFCs, from leaks and other releases under normal use of the products, can lead to high GHG emissions in CO_2-equivalent terms, due to the high global warming potential of these

[3] This reduction was largely the result of changes in North Carolina industrial activity and processes, rather than direct emissions reduction efforts. GHGs have not historically been considered pollutants or regulated in the same way that "criteria pollutants" (local and regional air pollutants such as oxides of sulfur and nitrogen) or hazardous air pollutants, and no post-combustion control/removal devices are commonly in use for CO_2, the major GHG species.

substances.[4] Figure 3-2 shows the estimated contribution of the individual sectors to RCI emissions over time.

Figure 3-2. 1990–2020 GHG emissions by sector and source



Key Challenges and Opportunities

The principal means to reduce RCI emissions in North Carolina include improving energy efficiency, substituting for electricity and natural gas with lower-emission energy resources (such as wind, solar water heating, photovoltaics, and biomass), reducing industrial-sector process (non-energy) emissions, increasing distributed (consumer-sited) electricity generation based on renewable fuels and on combined heat and power, and various strategies to decrease the emissions associated with electricity production (see Chapter 5, Energy Supply, for the latter). The state's limited implementation of energy efficiency programs and related initiatives in past years, relative to some other states that have aggressively pursued efficiency programs, provides a challenge—in rapidly assembling capacity to harvest energy efficiency resources—but also strong opportunities to reduce emissions through programs and initiatives to improve the efficiency of buildings, appliances, and industrial practices. An excellent start to building such programs and initiatives has been provided by the efforts of the State Energy Office (see, for example, the listing of Energy Office and other ongoing programs in NC provided in Annex A to the RCI Options Descriptions provided as Appendix E, by the recent Duke Energy and Progress

[4] Projections of energy consumption in the RCI sectors are based on *NC Energy Outlook 2003*. Prepared by Global Insight for the State Energy Office, North Carolina Department of Administration, May 2003. Projections for emissions from HFC use are Growth rates are based on growth in projected national emissions from U.S. Department of State, *U.S. Climate Action Report 2002*, Washington, D.C., May 2002. See http://yosemite.epa.gov/oar/globalwarming.nsf/UniqueKeyLookup/SHSU5BNQ76/$File/ch5.pdf.

Energy announcements that they will significantly expand their energy efficiency programs, by the recent passage of Senate Bill 3,[5] and by programs outlined in the State Energy Plan (see below). At the same time, North Carolina's robust population and economic growth, and the North Carolina's leaders' growing commitment to carry out significant emissions reductions, places pressure on communities and businesses in North Carolina to make swift decisions to put in motion changes that will reduce emissions. A key challenge lies in the design and implementation of strategies that address State goals and thus ensure that new buildings and industries take full advantage of opportunities to reduce energy use and emissions.

Though overall investment in energy efficiency to date has been limited relative to that in a number of other states, there are a number of existing programs in North Carolina that can readily be built upon to reduce greenhouse gas emissions. These include a number of programs and initiatives through the North Carolina State Energy Office (to be expanded by recent legislation), including programs related to energy efficiency, training and certification of energy sector professionals, and others. Local organizations have provided building and industrial energy technical assistance (energy audits) for many years, and the North Carolina Greenpower program, offering consumers electricity generated from renewable sources, is ongoing. A systems benefit charge-funded program for energy efficiency and other services has likewise been operating in the State for many years, and several utilities have programs addressing energy efficiency through provision of low-interest loans and direct incentives. The State Energy Plan, first updated and published in 2003 and revised in 2005 (further updates are currently underway), identifies a strong list of initiatives to increase energy efficiency in the RCI sectors and in other areas of the North Carolina economy[6]. While an indication of the growing efforts for improving efficiency and reducing emissions in North Carolina, these programs need to be further supported and extended to realize the overall potential of the state to slow its growth of energy use and emissions of GHG pollutants.

Overview of Mitigation Recommendations and Estimated Impacts

The CAPAG recommends a set of 11 mitigation options for the residential, commercial, and industrial sectors (including industrial process emissions from sources other than energy use) that offer the potential for major economic benefits and emissions savings. As summarized in Figure 3-3, these mitigation options, if fully implemented, could lead to emissions savings from reference case projections of 33 $MMtCO_2e$ per year by 2020, and cumulative savings of 219 $MMtCO_2e$ from 2007 through 2020.[7] The mitigation options recommended could result in net

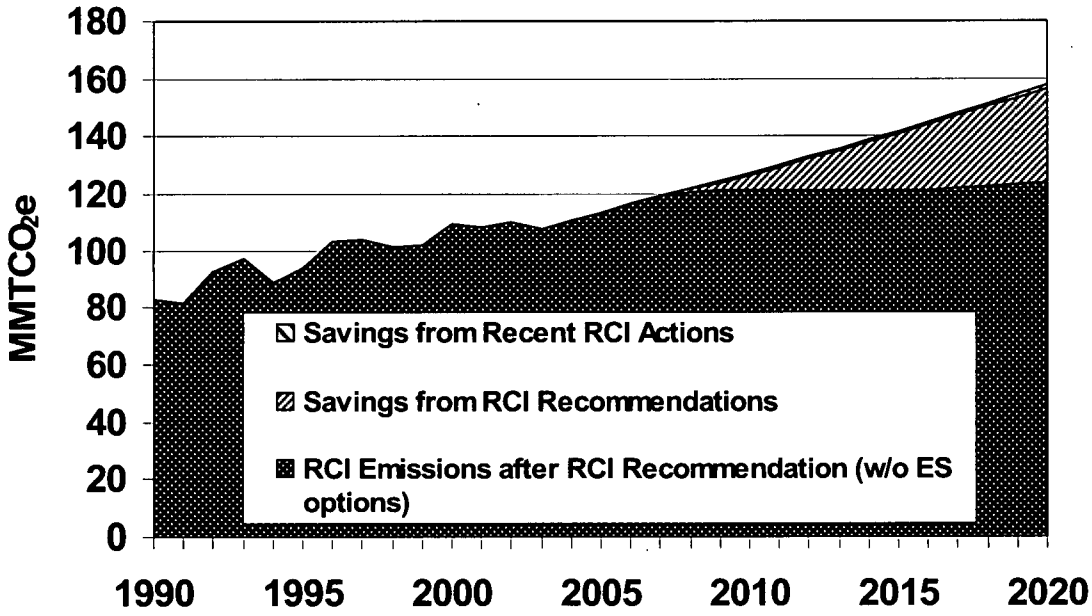
[5] See, for example, http://www.ncleg.net/Sessions/2007/Bills/Senate/HTML/S3v6.html. Senate Bill 3, among other provisions, includes "Renewable Energy and Energy Efficiency Standards (REPS) for Electric Public Utilities". This bill passed in August 2007 and has been signed into law.

[6] See *North Carolina State Energy Plan*, prepared for the North Carolina Energy Policy Council by the State Energy Office, North Carolina Department of Administration and Appalachian State University Energy Center (Revised edition January, 2005), available as http://www.energync.net/epc/docs/Energy%20Plan%202005.pdf.

[7] Note that these figures do not include additional emission savings from recent actions that were not already accounted for in the reference case projections. See the Appendix E for more detailed information on these options, including details of how costs and savings of the options were calculated. Of the total 219 $MMtCO_2e$ in cumulative emissions savings from the RCI policies, 211 $MMtCO_2e$ are from reduced electricity consumption, 8 $MMtCO_2e$ are

cost *savings* of nearly $4.0 billion through the year 2020 on a net present value basis (NPV).[8] Most emissions savings from the RCI options are in the form of reduced carbon dioxide emissions, with relatively minor reductions of emissions of other greenhouse gases (principally methane and nitrous oxide) produced via leakage and/or combustion of fuels.

Figure 3-3. Impact of CAPAG mitigation option recommendations on RCI emissions



The estimated impacts of the RCI mitigation options recommended by the CAPAG are shown in Table 3-1.[9] Also shown in Table 3-1 are the results of several ongoing initiatives in North Carolina. These "Savings from Recent RCI Actions" are not accounted for in the reference inventory and forecast, but contribute to overall emissions reduction along with savings from the CAPAG-recommended measures. The combination of savings from recent actions and CAPAG mitigation options are, in the RCI sectors, estimated to be approximately the same as the projected reference case growth in emissions from 2007 through 2020, as shown by the trend in the dark area in Figure 3-3.

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from the reduction in on-site use of fossil fuels, though the latter total does not include avoided heating fuel savings from implementation of combined heat and power systems.

[8] The net cost savings are calculated based on options costs that include fuel expenditures, operations, maintenance, and administrative costs, plus amortized, incremental equipment (capital) costs, less the costs of fuels and electricity that are saved as a result of implementation of RCI options. All NPV values described have been calculated using a 5% annual real discount rate.

[9] Note that "UC" in the right hand "Level of Support" column of Table RCI 1 indicates that the option was recommended by the CAPAG by unanimous consent of the CAPAG members present at the meeting where the option was reviewed.

The CAPAG mitigation option recommendations described briefly here, and in more detail in Appendix E, result not only in significant emissions and costs savings, but offer a host of additional benefits as well. These benefits include – but are by no means limited to – potential investments in other areas of the economy as a result of reduced spending on energy by homeowners and businesses, contributions to local economic development, job growth, and enhancement of productivity, reduced local air pollution and related reduced impacts of air pollution on human health, reduction in the needs for and costs of electricity transmission and distribution system additions, and improvements in comfort, convenience, and indoor air quality as a result of building improvement measures.

In order for the RCI mitigation options recommended by the CAPAG to yield the levels of savings described here, the options must be implemented in a timely, aggressive, and thorough manner. This means, for example, not only putting the options themselves in place, but attending at the same time to the development of "supporting options" that are needed to help make the recommended options effective. Many of these supporting mitigation options are a part of the package of RCI options, while others are included among the mitigation options recommended as "cross-cutting" options (see Chapter 7), and/or in options recommended in other chapters of this report (most notably, in the case of RCI, in the Energy Supply Chapter). Improved building energy codes (RCI-6) will not be optimally effective, for example, without further support and intensified training of contractors, builders, architects, financial institutions, and building inspectors, among others, in the methods and benefits of efficient building design, and of building code enforcement (as recommended, in part, in RCI-8). Given that the way that energy-efficiency improvements made as buildings are constructed will save energy over the entire, often long, lifetime of those buildings, modest investments now in building codes, training for building sector professionals, and code enforcement will yield significant cost, energy, and GHG emissions savings for decades. Regulatory changes that provide incentives and lower disincentives for the adoption of consumer-sited combined heat and power and renewable electricity generation are also among the supporting initiatives crucial to the success of the RCI options recommended by the CAPAG; some of these options are already in the formative stages in North Carolina. The CAPAG's work indicates that there are considerable benefits to both the environment and to consumers from adoption of the mitigation options recommended, but careful, comprehensive, and detailed planning and implementation, as well as consistent support (building on existing North Carolina programs and capacity whenever possible), of these options, and the initiatives and activities that they include, will be required if these benefits are to be achieved.

Table 3-1. CAPAG-recommended GHG emissions mitigation options and results for the RCI sectors

	Mitigation Option Name	GHG Reductions ($MMtCO_2e$)			Net Present Value 2007–2020 (Million $)	Cost-Effective-ness ($/tCO_2e$)	Level of Support
		2010	2020	Total 2007-2020			
	Residential, Commercial, and Industrial						
RCI-1	Demand Side Management Programs for the Residential, Commercial and Industrial Sectors	1.9	11.6	77.1	–1,895	–25	UC
RCI-2	Expand Energy Efficiency Funds	1.5	8.0	54.8	–1,346	–25	UC
RCI-3	Energy Efficiency Requirements for Government Buildings	0.0	1.1	6.4	–88	–14	UC
RCI-4	Market Transformation and Technology Development Programs	0.0	2.0	10.5	–339	–32	UC
RCI-5	Improved Appliance and Equipment Efficiency Standards	0.0	1.0	5.3	–336	–63	UC
RCI-6	Building Energy Codes	0.5	3.5	23.1	–400	–17	UC
RCI-7	"Beyond Code" Building Design Incentives and Targets, Incorporating Local Building Materials and Advanced Construction	0.7	5.2	34.2	–494	–14	UC
RCI-8	Education (Consumer, Primary/Secondary, Post-Secondary/ Specialist, College and University Programs)	*Not quantified*					UC
RCI-9	Green Power Purchasing (required for state facilities) and Bulk Purchasing Programs for Energy Efficiency or Other Equipment	0.1	0.5	3.5	11	3	UC
RCI-10	Distributed Renewable and Clean Fossil Fuel Power Generation	1.2	4.6	33.5	392	12	UC
RCI-11	Residential, Commercial, and Industrial Energy and Emissions Technical Assistance and Recommended Measure Implementation	0.5	2.1	14.9	–494	–33	UC
	Sector Total, after adjusting for overlaps	**5.3**	**33.0**	**218.7**	**–3,994**	**–18**	N/A
	Reductions From Recent Actions (see table below)*	0.5	1.2	10.1			
	Sector Total Plus Recent Actions	**5.8**	**34.2**	**228.8**			N/A

Emissions reductions associated with recent actions (and not included in reference case projections) that are related to RCI mitigation options

Option Number	Mitigation Option	Estimated 2010 GHG Reduction ($MMtCO_2e$)	Estimated 2020 GHG Reduction ($MMtCO_2e$)	Cumulative 2007–2020 GHG Reduction ($MMtCO_2e$)
RCI-1	Demand Side Management Programs for the Residential, Commercial and Industrial Sectors	0.3	0.7	6.2
RCI-2	Expand Energy Efficiency Funds	0.2	0.4	3.6
RCI-6	Building Energy Codes	0.0	0.0	0.0
RCI-9	Green Power Purchasing (required for state facilities) and Bulk Purchasing Programs for Energy Efficiency or Other Equipment	0.0	0.0	0.3

UC = unanimous consent; N/A = not applicable.

Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings associated with the options.

* "Recent actions" represent initiatives undertaken in North Carolina that reduce GHG emissions that were implemented shortly before or during the CAPAG process. The emission reductions associated with recent actions are not accounted for in the GHG emissions inventory and reference case projections. Emissions reductions associated with these recent actions were therefore estimated separately, and are counted toward overall statewide reductions along with reductions from the mitigation options recommended by the CAPAG.

Residential, Commercial, Industrial (RCI) Mitigation Option Descriptions

The Residential, Commercial, Industrial Sectors include emissions reduction opportunities related to improving energy (and sometimes water) use efficiency, using lower-GHG energy sources, and increasing consumer-sited renewable electricity generation and use of combined heat (and/or cooling) and power (CHP) systems. Additional detail on each of the options summarized below can be found in Appendix E.

RCI-1 Demand-Side Management Programs for the Residential, Commercial, and Industrial Sectors

The CAPAG recommends that Demand-side Management (DSM) programs funded by gas and electric utilities in North Carolina be expanded to yield higher levels of energy savings, demand response, and greenhouse gas emissions savings. Utility-funded DSM programs reduce either the consumption of or the demand for conventional sources of electricity and fossil fuels. Examples of DSM programs include technical assistance for and implementation of energy efficiency and renewable energy measures, electrical (and in some cases fuel) demand responses, alternative rate schedules, and research activities. The goal for this option is to reach a level of DSM investment in North Carolina equal to 1.5% of utility revenues by 2012. This option is designed to work in tandem with other strategies recommended by the CAPAG, including options described in other Chapters in this Report, which can also encourage efficiency gains.

Specific recommendations from the RCI TWG include proposing that the North Carolina General Assembly and the North Carolina Utilities Commission take an active role in encouraging the investor-owned, cooperative and municipal utilities to pursue active DSM programs.

Examples of utility-funded programs that this option supports include:

- Residential building programs—including programs to promote higher efficiency new and existing homes, and the expanded use of renewable energy in residences, with specific programs focused on the often under-served low-income and rental properties segments[10];
- Commercial and industrial building programs, including efficiency programs for new and existing buildings, and renewable energy programs for commercial and industrial buildings; and

[10] See the RCI Options Descriptions in Appendix E, and the discussion of existing programs in these areas developed by the State Energy Office, Appalachian State University, and others provided in Annex A to Appendix E.

- Multi-sector strategies, including demand response and demand reduction programs, technical assistance, education, training, consumer outreach, and promotional activities to support the DSM programs, and grants, loans, performance contracting arrangements, and other incentive programs to provide financial support or incentives for implementation of DSM programs.

RCI-2 Expand Energy Efficiency Funds

The CAPAG recommends that North Carolina's existing Public Benefits Charge be significantly increased to support more investments in energy efficiency and renewable energy options. The public benefits charge (sometimes call systems benefits charge) is a fee assessed to utility customers based on their usage of energy in a given time period. With deregulation in many states, utility commissions often lose the ability to require the electric utilities to have efficiency programs. The result in many states is the development of the public benefits charge, which is a non-bypassable charge on electric bills. The funds collected are then provided to a third party to provide energy efficiency programming. The CAPAG recommends that these increased public benefits charges be collected under the oversight of the NC Utilities Commission, and invested in residential, commercial, and industrial energy efficiency and renewable energy programs through one or more third-party administrators. Long-term consistency in management and dedicated application of funds collected via public benefits charges to the target programs will be crucial to the success of this initiative.

Investments in energy efficiency and renewable energy made using public benefits funds would be expected to span a wide variety of residential, commercial and industrial applications.

The CAPAG set the goal of this option as providing public benefit charges adequate to implement energy efficiency and renewable energy programs comparable to the more effective public benefits charge-funded programs in the United States. Based on information on energy efficiency programs in other states, 1% of utility revenues was chosen as an appropriate public benefits charge goal for North Carolina at present[11].

RCI-3 Energy Efficiency Requirements for Government Buildings

Recognizing that governments should "lead by example" the CAPAG recommends that energy use targets be set and worked toward to improve the efficiency of energy use in State and local government buildings. This option sets energy-efficiency goals for the existing government building stock, as well as for new construction and major renovations of government buildings.[12]

Elements of this option include:

[11] The recently enacted Senate Bill 3, as referenced above, includes some similar elements to those proposed in this option.

[12] Note that some of the elements of this option have been included in the recently-signed Senate Bill 668, "Energy Conservation in State Buildings". See http://www.ncleg.net/Sessions/2007/Bills/Senate/HTML/S668v6.html.

- Adherence by new and renovated government buildings to specific energy-related guidelines providing considerable improvement in building energy performance relative to standard practice, with a specific goal of reducing the energy consumption per square foot of government building area in North Carolina by 20% by 2027.
- Revising administrative policies as needed to provide incentives for government organizations to invest in increased energy-efficient construction or building alterations.
- Extending green campus initiatives to all public academic and government campuses.
- Energy benchmarking, measurement, and tracking programs for municipal and state buildings.
- Energy efficiency and renewable energy requirements for new, renovated, and existing government buildings.

RCI-4 Market Transformation and Technology Development Programs

The CAPAG recommends that North Carolina develop long-term and robust market transformation and technology development programs. Such programs must provide 1) consistent and enduring support for technology improvement and incorporation, 2) continued investment in technology development and integration, and 3) independent evaluation of the efficacy of the technologies.

This recommendation is broadly defined and does not address a particular technology or market. Rather, it addresses a method for bringing appropriate technologies and processes to the marketplace. Defined as such, the CAPAG recommends that the following components be included in market transformation strategies for North Carolina, though others can and should be included as well:

- Expand existing programs to promote the appropriate use of premium motors and drives in industrial applications.
- Provide renewed and intensified support for implementation of renewable energy applications such as solar water heaters.
- Target the early retirement of older appliances using a "bounty" program.
- Provide support for processes that recover waste heat from industrial applications, and promote the use of ground-source heat pumps by helping to identify and qualify appropriate applications in the residential, commercial and industrial sectors.
- Encourage national legislators to provide increased federal funding for the U.S. Environmental Protection Agency's ENERGY STAR program in order to identify and qualify a greater number of products under ENERGY STAR labeling.

- Encourage and enable smaller purchasers to act in aggregate groups to reduce costs and quantify emission reduction benefits from technology and process improvements. This could include, for example, setting up programs to organize consumers and to work with them to provide information resources to evaluate and take advantage of savings emissions reduction opportunities.

- Provide a continuous funding level for near-term research and deployment of energy efficient technologies and processes, including providing stable or expanded state funding for existing programs and new initiatives.

Implementation of market transformation programs requires the participation and buy-in of industry partners, regulatory bodies and consumer groups.

RCI-5 Improved Appliance and Equipment Efficiency Standards

The CAPAG recommends that North Carolina should replicate the appliance and equipment efficiency standards adopted in other states for appliances not covered by federal standards[13]. As part of this action, the CAPAG recommends that the State, working together with other states in, should advocate for stronger federal appliance efficiency standards where doing so is technically feasible and economically justified[14]. Implementation of stronger-than-federal standards together with other states is much preferred by the CAPAG, as it provides a broader market for manufacturers and thus lowers net costs of higher-efficiency devices to North Carolina consumers. The CAPAG recommends that development of new standards start in 2010, with implementation starting in 2012.

Elements of this mitigation option include:

- Development of committee or other working group to develop recommendations on appliance standards (similar to, for example, the existing North Carolina group that considers building code changes).

- Adoption of State-level Appliance Efficiency Standards, defined sufficiently broadly to include, for example, commercial sector and information technology (IT) equipment.

- The CAPAG voices support for adoption of more stringent federal-level appliance efficiency standards, and recommends that North Carolina's congressional delegation and state government officials voice support for such standards.

- Design standards for recycling of materials in appliances, and include water use reduction as a criterion for appliance efficiency improvement.

[13] A few examples here of devices not currently covered by Federal standards are commercial boilers, distribution transformers, and AC to DC power supplies. See www.standardsasap.org and Appendix E.

[14] For example, where changes in efficiency can be implemented by manufacturers in such a manner that the value of energy savings, and perhaps eventually the value of GHG emissions savings, is greater than equal to the increased cost of production of the appliance or equipment.

- Assistance programs to help low-income consumers with purchase of appliances meeting more stringent standards, so as to reduce the higher-first-cost burden of higher-efficiency appliances on those consumers.

- Introduce elevated energy standards for appliances and equipment purchased by public agencies.

- Encourage state agencies, utilities, and other organizations involved in appliance and equipment efficiency programs to work with manufacturers to identify devices where significant savings are possible, and to consider cost and technical impacts on manufacturers—and how to address those impacts—when setting new standards.

RCI-6 Building Energy Codes

The CAPAG recommends that North Carolina upgrade the energy-efficiency provisions of its building codes, and hasten implementation of standards already adopted or awaiting adoption. Building energy codes specify minimum energy efficiency requirements for new buildings or for existing buildings undergoing a major renovation. As energy use (largely electricity and gas) in buildings in North Carolina accounts for about one-third of current emissions, amending the Building Codes to make the requirements for minimum energy efficiency levels in buildings more stringent will have a considerable immediate and ongoing impact in reducing building-sector greenhouse gas emissions.

An ongoing process of code amendments for new and renovated residential and commercial buildings is proposed as follows[15].

- North Carolina should adopt more stringent building codes to improve the efficiency of energy use in buildings.

- North Carolina should move toward adopting innovative features of advanced codes being implemented in other states, such as lighting efficiency requirements in new homes that go beyond the codes in force, as appropriate to conditions in the State.

- Statewide enforcement of both existing and new building codes should be improved at all levels, and enforcement should be fully implemented within 6 months of statewide code adoption (if applicable).

- North Carolina should regularly update its energy codes to assure that they remain consistent with stringent codes in use nationally and internationally. A three-year cycle of code review and improvement could be timed to coincide with the release of national model codes.

[15] As with other RCI options, please see Appendix E for additional details on the suggested building code improvements.

- As appropriate, codes should be modified to remove obstacles to renewable energy use, daylighting and non-conventional energy-efficient building materials in buildings where applicable.

- Include programs of expanded, more accessible and intensified education for building inspectors and other building industry professionals to assure that the new codes are implemented and enforced.

The CAPAG recommends 95% enforcement of existing building energy codes by 2008, and establishment and similar enforcement of a new energy code by 2010 that requires new North Carolina residences and commercial/industrial buildings to be 20% more efficient than buildings meeting current national building energy codes.

RCI-7 "Beyond Code" Building Design Incentives and Targets, Incorporating Local Building Materials and Advanced Construction

Energy use in existing buildings and in non-government-funded new buildings must be substantially improved. The CAPAG recommends that incentives and targets be provided and developed to induce the owners and developers of new and existing non-government buildings to markedly improve the efficiency with which energy and other resources are used in those buildings, along with provisions for raising targets periodically and resources to help achieve the desired building performance. This option includes elements to encourage the improvement and review of energy use goals over time, and to encourage flexibility in contracting arrangements to encourage integrated energy and resource efficient design and construction.

Elements of this option include:

- Promotion and Incentives for "beyond code" construction, using programs of various types to focus on specific sectors (new home construction, apartments, low income housing, commercial new construction, commercial renovation construction, and others), with improved design and construction standards and guidelines addressing multiple aspects of resource conservation.

- Promotion of energy technologies include solar water heating and solar heating/cooling building technologies, solar photovoltaic power on commercial buildings and many new homes, solar hot water heaters on homes and other buildings, new and existing lighting building energy technologies, and other applicable new technologies.

- Promotion of energy education under this option in coordination with the programs noted in RCI-8.

- The goals of this option are to induce 5% of new residential buildings and 2% of new commercial buildings annually to go to "beyond code" energy use levels that improve energy performance over the average new building by 30%, to induce significant examples throughout the state of various building types that use 50% or less energy than is supported by the existing building code, and to provide incentives such that energy efficiency in 20% of

existing buildings is increase by 15% by 2015, and energy efficiency in 20% of existing commercial building energy performance is increased by 20%. These goals are intended to be in addition to privately and publicly-sponsored efforts at "beyond code" construction now ongoing in North Carolina.

RCI-8 Education (Consumer, Primary/Secondary, Post-Secondary/Specialist, College and University Programs)

The CAPAG notes that the effectiveness of emissions reduction activities in many cases depends on providing information and education to consumers, as well as to future consumers (primary and secondary school students), regarding the energy and greenhouse gas emissions implications of consumer choices. As a consequence, the CAPAG recommends that consumer and primary/secondary schools education programs focused on these issues be created in North Carolina, or augmented and expanded where they exist already. In addition, in order to effectively implement many of the other RCI options above, specific and targeted education (at the community college, university, and post-graduate levels), outreach, and licensing requirements will be required for professionals in a variety of building-related trades in order to ensure that those professionals have the expertise to support aggressive GHG mitigation options in North Carolina. State support for such programs will help to build a pool of trained professionals that will benefit the state for years to come.

Training and education activities under this option should be implemented so as to fully support other RCI options, and options in other areas as applicable, and should be timed and provided at levels appropriate so as to build understanding and awareness of energy and environmental issues, and human capacity in the field (skilled worker and professionals) so that capacity will be ready when needed by the people and businesses of North Carolina.

Elements of this option include training, education, and certification for builders and contractors, training and certification of building code and other officials in energy code enforcement, energy management training and training of building operators, continuing education for building design professionals, including architects, engineers, developers, contractors, urban planners, and realtors, energy efficiency and related education introduced at community colleges and trade schools, consumer education and consumer information programs (building on efforts to date by the State Energy Office, the NC Energy Research Center at Appalachian State University, and others), and introduction/augmenting of energy and environmental curricula in schools.

RCI-9 Green Power Purchasing (required for State facilities) and Bulk Purchasing Programs for Energy Efficiency or Other Equipment

The CAPAG recommends that the use of "green power" in North Carolina be significantly expanded, and that public- and private-sector programs for the bulk purchase of high-efficiency appliances and equipment be developed. "Green power" supplements the state's existing power supply with electricity generated from renewable resources like the sun, wind and organic matter. This option expands an existing voluntary North Carolina program by making green power purchases mandatory for State facilities. As part of this strategy, the CAPAG also

recommends establishing a program for the bulk purchase of appliances and equipment with higher-than-standard energy efficiency by public agencies, and for the organization of similar bulk-purchase programs in the private sector.

The CAPAG recommends that State facilities purchase energy through NC GreenPower or a similar green power provider to cover 20% of their power needs by 2018, over and above the requirements of renewable generation within an Environmental Portfolio Standard or similar requirement applying to electricity suppliers. This target would be phased in starting in 2008. Additionally, for bulk purchases, the CAPAG recommends a program to address purchases of 10% of electricity-consuming equipment purchased annually by state agencies, and 1% of electricity-consuming equipment purchased annually by all commercial/institutional sector consumers. Devices purchased under the energy efficiency bulk purchase program would have a target consumption of 20% less electricity, on average, than devices that would otherwise have been purchased.

RCI-10 Distributed Renewable and Clean Fossil Fuel Power Generation

The CAPAG recommends that implementation of distributed renewable and clean fossil fuel power generation systems of less than 10 MW be encouraged through a combination of regulatory changes and incentive programs. Distributed generation with clean power systems reduces fossil fuel use and greenhouse gas emissions as well as providing electricity system benefits.[16] Elements of this program include:

- Review existing net-metering policies (or check that the most recent North Carolina reviews of these policies are complete), including policies that affect electricity consumers who install on-site combined heat and power or distributed generation fueled with renewable or fossil fuels.
- Review as needed, and in consultation with the NC Utilities Commission, rate issues in NC, including the potential for decoupling of utility revenues from sales and rate design, with a specific focus on the impacts of rate design on greenhouse gas emissions.
- Provide incentives, including, as needed, increasing existing tax and utility incentives, for renewable energy applications such as photovoltaics and other renewable power sources, sufficient to reach the renewable energy development goals below.
- Promote clean combined heat and power in all sectors through, for example, a combination of utility incentives, information provision, streamlining of connection requirements, providing low-interest loans, and/or tax credits for potential hosts/owners/developers of these systems.
- Funding of research and development for distributed renewable and clean fossil fuel power generation, and provide direct or indirect support for in-state commercialization and

[16] Electric system benefits can include, for example, reducing the need for transmission and distribution capacity by providing generation at the local level, and providing voltage and frequency support.

production of new or advanced technologies for distributed renewable and clean fossil fuel power generation.

- Encourage the development of building-integrated distributed renewable and clean fossil-fuel power generation.

The goal of the program would be to implement 25%–33% of North Carolina's combined heat and power potential by 2020. An additional 2% to 4% of all NC homes will have solar hot water installations by 2020. This option also includes the goal of implementing 35 additional MW of distributed renewable generation over and above renewable portfolio standard-related new generation by 2020.

RCI-11 Residential, Commercial, and Industrial Energy and Emissions Technical Assistance and Recommended Measure Implementation

The CAPAG recommends that technical assistance be provided to help identify options for energy consumers to reduce fossil energy use and to reduce non-energy emissions of GHGs, and that consumers be provided with information and incentives allowing them to follow-up on that assistance to implement recommended measures. This initiative may include the following elements:

- Residential energy technical assistance for existing homes that identifies the most cost-effective energy efficiency measures for the individual homes visited. The technical assistance program can include diagnostic testing and analysis specific to the features of the home being investigated. The results reported to the homeowner can provide estimates of energy use, energy cost savings, and reductions in emissions due to implementation of the recommended measures.

- Commercial energy technical assistance for existing commercial buildings similar to the residential services, but most likely not including diagnostic testing. The analysis associated with technical assistance can also consider the benefit to the individual businesses visited of being served under alternative utility rate structures and of taking advantage of load control opportunities.

- Industrial energy technical assistance that identifies key efficiency measures, such as process heat changes, motor efficiency improvements, boiler efficiency provisions, compressed air system measures, as well as lighting and building envelope efficiency improvements. The industrial technical assistance program can identify opportunities for capture and use of process heat, as well as for implementation of combined heat and power. Opportunities for reducing the use of non-energy greenhouse gases can also be considered. Evaluation of the benefit to the individual plants visited of being served under alternative utility rate structures and assessments of load control opportunities can be included as well.

- The technical assistance programs can include follow-up mechanisms by which those who receive services are contacted at least twice after receiving the results to answer questions and give suggestions for installing the recommended measures, and to provide access to

incentives (such as grants to cover a portion of the incremental cost of efficiency improvements) and financial assistance (such as low-interest loans) to encourage implementation of recommendations.

Initial goals for this option are to provide over 10,000 residential technical assistance visits, 1,500 commercial building technical assistance visits, and 300 industrial technical assistance visits annually once the technical assistance programs are fully implemented, and to have over 50% of consumers provided with assistance visits implement measures providing at least 50% of the GHG emission reduction potential of the recommendations. The CAPAG recommends that these goals be increased if needed, over time, to help to fully implement other RCI options.

Chapter 4
Energy Supply

Overview of GHG Emissions

Greenhouse gas (GHG) emissions from the energy supply (ES) sector in North Carolina include emissions from electricity generation and represent a substantial portion of the State's overall GHG emissions (approximately 46% of gross emissions in 2000). A significant portion of North Carolina's gross GHG emissions are associated with electricity imports - roughly 8% of the State's electricity-related fossil fuel emissions were associated with imports in 2000, though this is expected to decline to about 6% by 2020 based on the reference case forecast. Overall, ES emissions are expected to increase from 1990 levels of 54 million metric tons (MMt) of carbon dioxide equivalent (CO_2e) to about 98 $MMtCO_2e$ by 2020, or by approximately 83% on a consumption basis If the current trends were not perturbed by some actions, such as implementation of the elements of these recommendations.

Figure 4-1. Historical and projected GHG emissions from the Electric Sector, North Carolina, 1990 to 2020 (consumption basis)

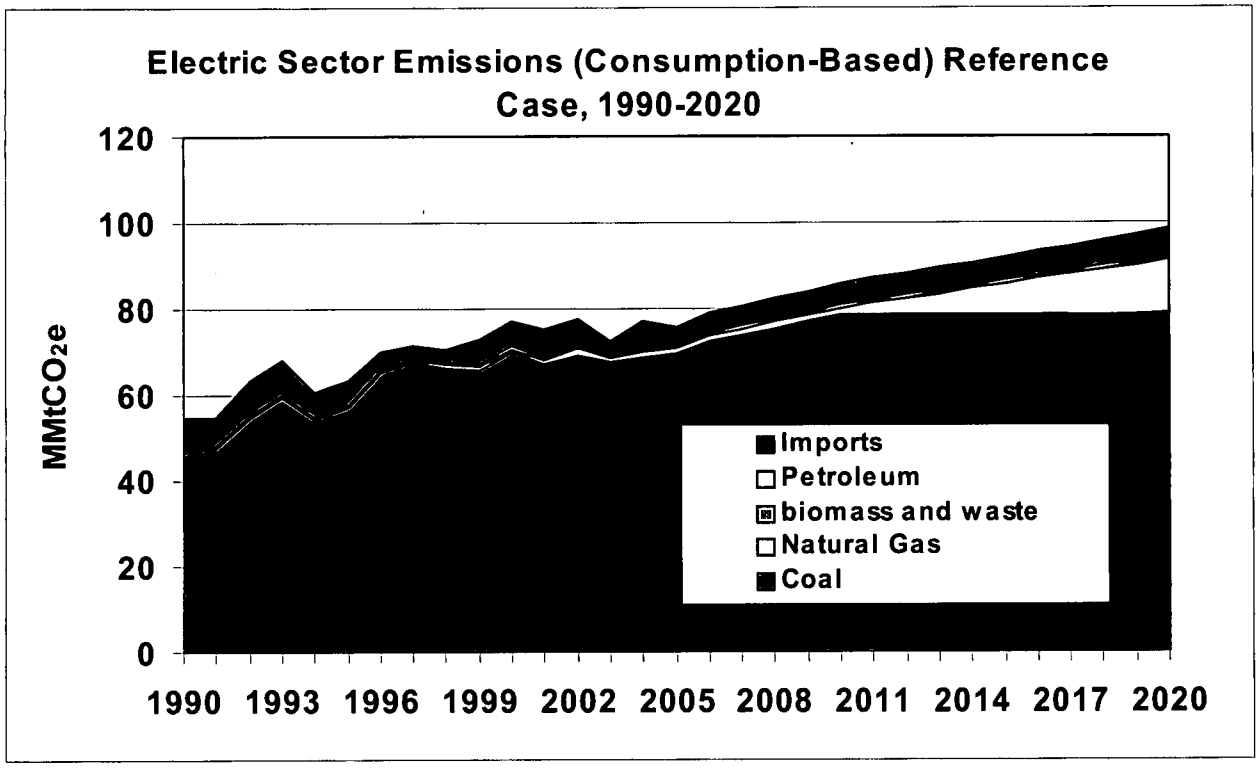
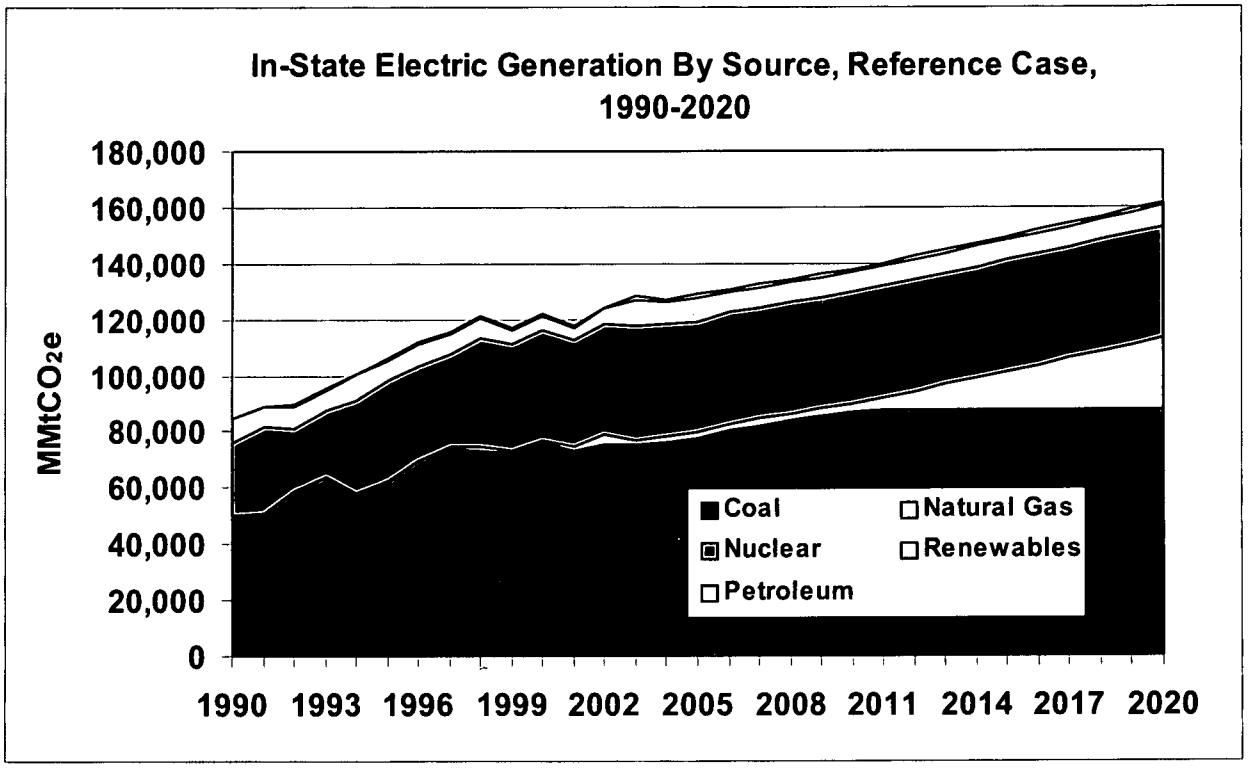


Figure 4-2. Historical and projected gross GHG emissions from electricity generation, North Carolina, 1990–2020



Key Challenges and Opportunities

The key challenge in addressing GHG emissions from North Carolina's ES sector is the continued growth of electricity demand within the State. Electricity sales are projected to grow annually at the rate of about 1.6% between 2003 and 2020. This challenge is compounded by the fact that there is expected to be continued significant reliance on electricity produced by coal-fired power stations. These units produced 59% of all electrical energy generated in the state in 1990. While the share of coal-fired electricity is projected to decrease slowly, it is still projected to be a relatively high 54% by 2020.

Fortunately, there are significant opportunities in North Carolina to reduce the GHG emissions growth attributable to energy production and supply, including diminishing the carbon intensity of electrical generation through greater use of renewable energy options, and recapture of waste energy through combined heat and power and other technologies. Significant opportunities to reduce GHG emissions through mitigation options addressing electricity consumption also exist, and can often provide net cost savings to consumers and to the State. The CAPAG has identified several demand-side management, energy efficiency, and conservation measures in the Residential, Commercial, and Industrial Sector; these are detailed in Chapter 3.

North Carolina has significant renewable resources in the form of biomass, wind and hydro energy. North Carolina also has untapped onshore and offshore wind resources, albeit not necessarily well located to meet domestic demand. The intermittent nature of winds inhibits its value for providing baseload capacity, but its value to the electricity grid can be enhanced by

carefully planning of wind facilities at multiple sites so they can support power demand in parts of the grid where it is most needed.

Overview of Mitigation Option Recommendations and Estimated Impacts

The CAPAG recommends a set of 9 mitigation options for the ES sector that offer the potential for significant GHG emission reductions. These recommendations include efforts to increase the supply of electricity from renewable energy sources (ES-1, ES-2, ES-8, and ES-10), encourage lower-emitting fossil fuel generation (ES-6), increase distributed generation and distributed combined heat and power (ES-3 and ES-9), implement cap in-state carbon emissions (ES-4), align environmental objectives within the planning process (ES-5), and reduce electricity demand (ES-7). A glance at the numbers in Table 4-1 would seem to suggest that if simply added together, the cumulative emission reductions of these mitigation options could exceed 800 $MMtCO_2e$ in 2020, and NPV costs could approach $4 billion, assuming all options are implemented in isolation from each other. These options are *not,* however, independently additive. In fact, they tend to overlap heavily, so simply summing them would introduce significant double-counting. These options essentially target – through different means – the avoidance of the same or similar emissions sources (e.g., the emissions from existing fossil-fuel power plants and those yet to be built). When taken together in a combined scenario that assumes all of the CAPAG's recommendations are fully implemented, these electricity supply recommendations are estimated to lead to cumulative GHG emissions reductions of about 78 $MMtCO_2e$ through 2020, at a NPV (net present value) cost of about $1.4 billion. (See Appendix F for discussion of the methodology used for the integrated analysis.)

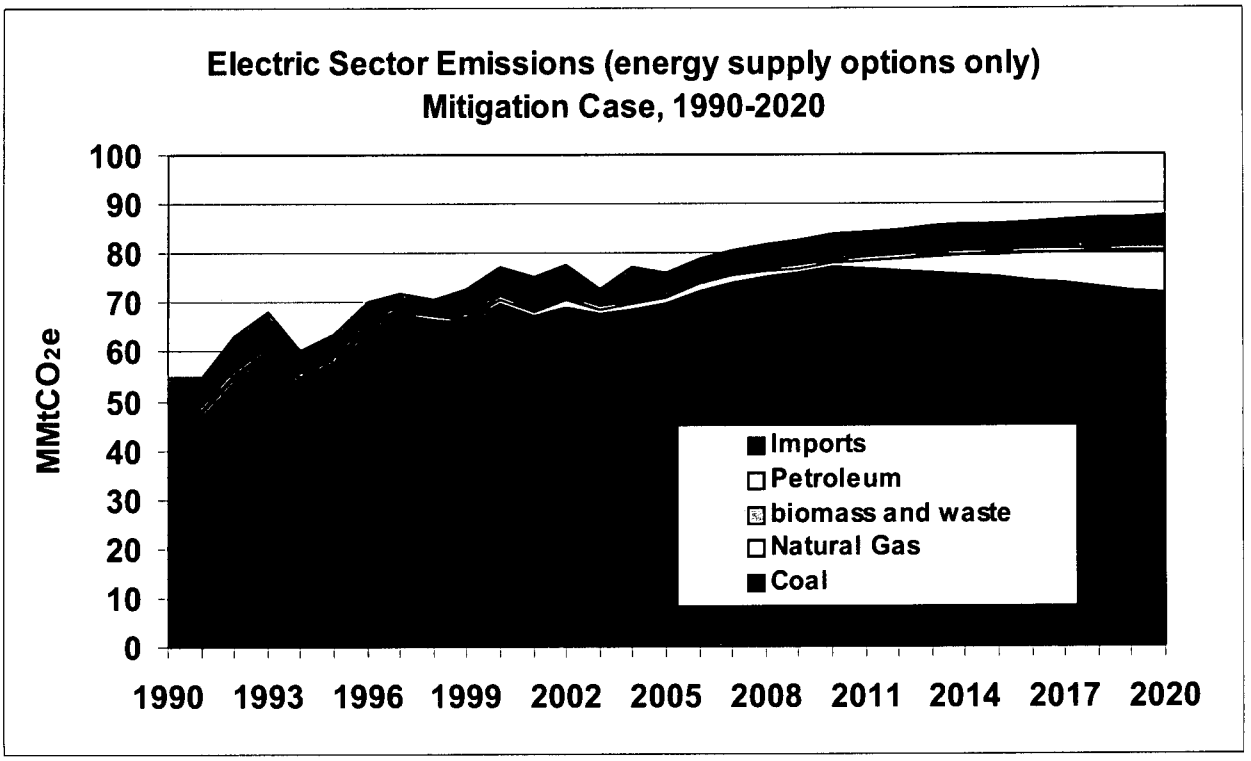
In fact, the CAPAG's recommendations concerning GHG emissions from electricity generation are also highly interactive with its RCI mitigation option recommendations concerning electricity use, because reducing electricity demand can offset the need for new generation, often at a lower cost or even with a savings. The scenario above (full implementation of all CAPAG recommendations) takes into account the many overlaps among ES and RCI mitigation options that reduce the demand for power.

The approach used for estimating emission reductions and costs associated with the combined set of ES and RCI mitigation options involved four major steps. First, electricity saving overlaps among RCI options was accounted for to eliminate the possibility of double-counting. Second, aggregate costs associated with the achieving total demand-side electricity savings were estimated. Third, revised electric generation requirements were estimated that accounted for savings associated with energy efficiency options. Finally, a revised electric generation mix was determined that accounted for renewable energy and other ES options.

Overall, the combined ES and RCI recommendations yield potential reductions in electricity sector emissions from reference case projections of about 63 $MMtCO_2e$ per year by 2020 and cumulative reductions of 375 $MMtCO_2e$ from 2007 through 2020, at a net savings of

approximately $6 million through the year 2020 on an NPV basis. These combined ES and RCI results are shown in Figures 4-3 and 4-4.[1]

Figure 4-3. Impact of electric supply options on electricity sector emissions



The estimated impacts of the recommended ES mitigation options are shown in Table 4-1. The CAPAG mitigation option recommendations described briefly here (and in more detail in Appendix F to this report) result not only in significant emissions savings, but offer significant additional benefits as well. A substantial expansion of renewable energy in North Carolina, for instance, may be accompanied by a corresponding increase in related jobs in North Carolina as energy investment shifts from fossil fuel production to the manufacture of renewable technologies. Energy reliability and security could be enhanced by the greater penetration of distributed and renewable energy resources into the energy marketplace, and air pollution-related public health and visibility impacts would decline with reduced fossil fuel-fired emissions from electricity generation. Nevertheless, some renewable sources (i.e., biomass) do emit small levels of GHGs.

[1] The net cost savings are based on fuel expenditures, operations, maintenance, and administrative costs, and amortized, incremental equipment costs. All NPV analyses here use a 5% real discount rate.

Figure 4-4. Impact of supply- and demand-side mitigation option recommendations on electricity generation sector emissions

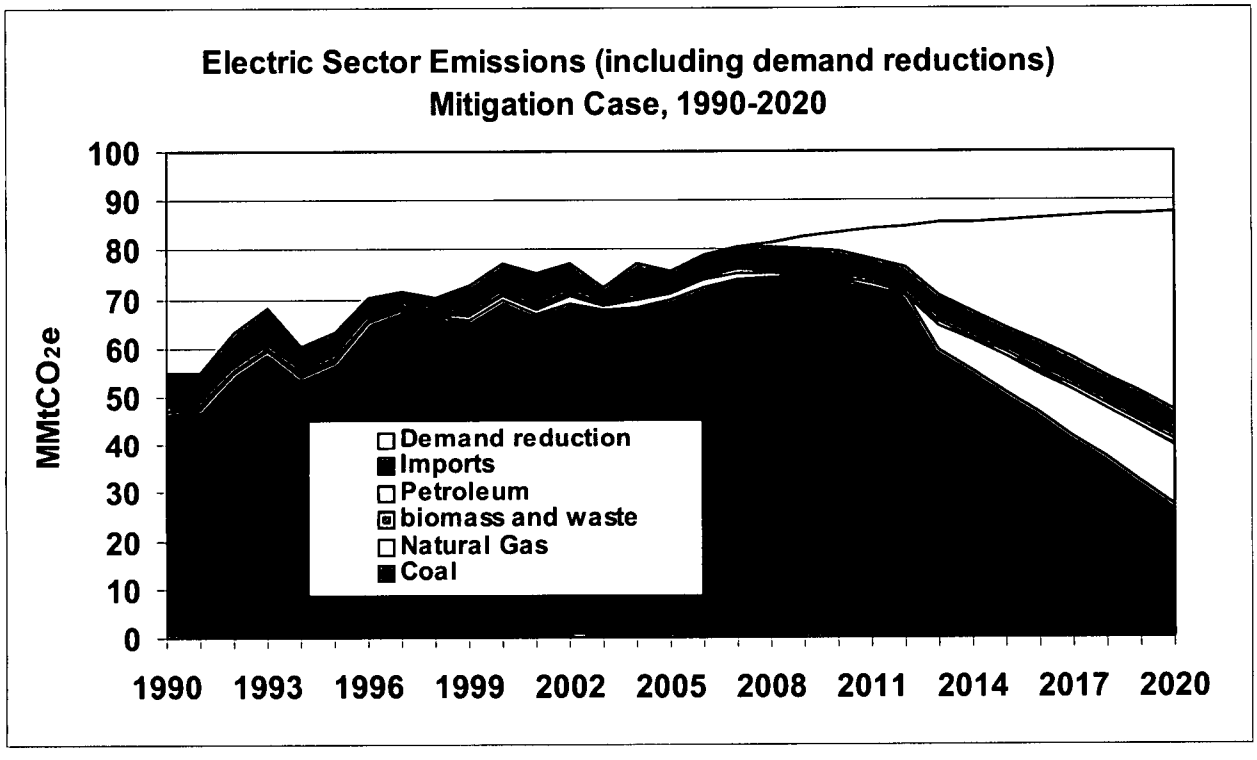


Table 4-1. CAPAG-recommended mitigation options and results for the Energy Supply sector

	Mitigation Option Name	GHG Reductions ($MMtCO_2e$)			Net Present Value (Million $)	Cost-Effective-ness ($/tCO_2e$)	Level of Support*
		2010	2020	Total 2007–2020			
ES-1	Renewable Energy Incentives	0.01	0.04	0.33	15	45.1	UC
ES-2	Environmental Portfolio Standard						
ES-2a	Original analysis	6.94	44.3	288.7	1,634	5.7	UC
ES-2b	20% combined target	5.90	23.4	166.2	409.80	2.5	UC
ES-2c	Load growth offset target	5.53	22.3	160.3	393.95	2.5	UC
ES-3	Removing Barriers to CHP and Clean DG	0.69	2.8	20.1	127.98	6.4	UC
ES-4	CO_2 tax and/or Cap-and-Trade						
ES-4a	Electric sector only	0.84	3.3	20.4	119	5.8	SMJ
ES-4b	Economy-wide	1.84	7.1	47.7	284	6.0	SMJ
ES-5	Legislative Changes to Address Environmental and Other factors	Not quantified					UC
ES-6	Incentives for advanced coal						
ES-6a	Replacement of new 800 MW pulverized coal plant	0.00	3.9	31.0	949	30.6	UC
ES-6b	Replacement of Existing 800 MW Pulverized Coal plant	0.00	5.4	42.9	2,061	48.1	UC
ES-7	Public Benefit Charge	0.8	3.4	24.4	329	13.5	SMJ
ES-8	Waste to Energy	0.0	0.0	0.02	–0.7	–36.8	UC
ES-9	Incentives for CHP and Clean DG	Combined with ES–3					UC
ES-10	NC GreenPower Renewable Resources Program	0.01	0.2	0.95	35	37.0	UC
	SECTOR TOTAL AFTER ADJUSTING FOR OVERLAPS**	6.5	62.7	375	–5.9	–0.016	
	REDUCTIONS FROM RECENT ACTIONS (none)	0	0	0	0	0	
	SECTOR TOTAL PLUS RECENT ACTIONS**	6.5	62.7	375	–5.9	–0.016	

* UC = unanimous consent (all agree), SMJ = super majority (at least 80 percent or more agree).

** For ES-2, ES-4, and ES-6, emission reductions and costs associated with ES-2b, ES-4a, and ES 6a were used in the cumulative analysis.

Energy Supply Sector
Mitigation Option Descriptions

The ES sector includes emissions mitigation opportunities related to electricity generation. These options include mitigation activities associated with the generation, transmission, and distribution of electricity, whether generated through the combustion of fossil fuels or by renewable energy sources; in a centralized power station supplying the grid or by distributed generation facilities; or imported into the state.

ES-1. Renewable Energy Incentives (Biomass, Wind, Solar, Geothermal, Hydro)

This option focuses on financial incentives that promote the greater use of renewable energy. The incentives are focused primarily for residences, businesses, and other electricity end-users rather than for research and development, outreach, or inter-governmental programs. The effect of these incentives is to encourage investment in renewable power sources by providing direct financial support for adoption of these technologies.

ES-2. Environmental Portfolio Standard (Renewables and Energy Efficiency) with Renewable Energy Credit Trading

A renewable portfolio standard (RPS) is a mitigation option requiring investor-owned electric utilities to supply a certain percentage of retail electricity from renewable energy sources by a stipulated date. A type of RPS that includes measurable, verifiable and lasting efficiency options is an Environmental Portfolio Standard (EPS). Utilities can satisfy the renewable energy component of the EPS requirement by generating renewable energy themselves or by purchasing renewable energy credits (REC) from a renewable energy generator. A REC is equal to 1 kWh of eligible and verified renewable electricity produced

Three different targets were analyzed for the EPS, as briefly outlined in the bullets below:

- Aggressive target: this corresponds to a 31% combined energy efficiency and renewable energy target by 2020.
- 20% target: this corresponds to a 20% combined energy efficiency and renewable energy target by 2020.
- Load growth offset target: this corresponds to a combined energy efficiency and renewable energy target by 2020 that offsets load growth over that period.

ES-3 and ES-9. Removing Barriers and Providing Incentives to Combined Heat and Power (CHP) and Clean DG

Combined Heating Cooling and Power (CHP), also know as cogeneration, is a method of utilizing the thermal energy (heat) produced when generating electricity (power) in a single,

coordinated process. CHP is more energy-efficient than separate generation of electricity at a central electric plant and production of localized thermal energy for the end user. This distributed generation resource allows for recycling the heat, which is normally wasted to cooling towers or lakes at centralized electric generating stations, to meet onsite thermally-driven demand such as process and space heating, cooling, and dehumidification.

ES-4. CO_2 Tax and/or Cap-and-Trade (Covering Sources Including Fossil, Renewable, and Nuclear on Life Cycle Basis)

A cap and trade system is a market mechanism in which CO_2 and other GHG emissions are limited or capped at a specified level, and those participating in the system can trade permits (a permit is an allowance to emit one ton of CO_2 or its equivalent in other GHGs) in order to lower costs of compliance. For every ton of CO_2 (or other GHGs) released, an emitter must hold a permit. Therefore, the number of permits issued or allocated is, in effect, the cap on emissions. The government can give permits away for free (with permits distributed based on any one of many different criteria, to those participating in the cap and trade system or even to those who are not), auction them, or a combination of the two methods. Participants can range from a small group within a single sector to the entire economy, and can be implemented upstream (at the level of fuel extraction or import) or downstream at the points where fuel is consumed.

ES-5. Aligning Environmental and Profit Incentives Through Electric Sector Regulatory/Rate Reform

Several regulatory and rate reforms in North Carolina would encourage electric utilities to invest in clean, non-carbon-producing energy resources such as renewables and energy efficiency. Under the current rate structure, utilities have an incentive to invest in new large capital projects, which also may inhibit investments in energy efficiency. North Carolina could align the regulated electric utilities' profit motive with increased energy efficiency by removing perverse disincentives to energy efficiency.

ES-6. Incentives for Advanced Coal

Integrated gasification combined cycle (IGCC) is an emerging technology for coal-fired electricity generation, offering the potential for higher efficiency and reduced cost of pollutant emissions control. IGCC involves partially combusting coal under high pressure to produce a synthetic gas, which is then used in a combined-cycle combustion plant to generate electricity. IGCC can be combined with carbon capture and sequestration or reuse (CCSR) in North Carolina to lead to significant CO_2 emission reductions relative to those of conventional coal technology.

ES-7. Public Benefits Charge on Electric Bills to Support Energy Efficiency Programs

A public benefits charge (sometimes called a systems benefits charge) is a non-bypassable fee attributed to electric customers based on their electricity use in a given time period. The funds

collected are then provided to a third party to provide energy efficiency programming. The purpose behind public benefits charges is most often to reduce energy consumption. While efficiency improvements carry significant air quality and GHG benefits, this impact is rarely a consideration for creation of a program. In a GHG-constrained mitigation option context, these benefits boost the attractiveness of a public benefits charge option.

ES-8. Waste to Energy

The combustion of waste materials, or their conversion by biological or thermo-chemical means to an easily-used fuel, can be used to produce heating, cooling or electric generation with lower GHG emissions than many conventionally-fueled alternatives. This waste-to-energy mitigation option focuses exclusively on the use of methane derived from Municipal Sewage Treatment (MST) to produce electricity. This is due to the fact that the use of other waste resources to substitute for fossil fuels—including landfill gas (LFG), animal waste, agriculture waste, and forestry waste—are all covered under the Agriculture, Forestry, and Waste Management (AFW) TWG, and direct combustion of MSW is opposed by environmental interests.

ES-10. NC GreenPower Renewable Resources Program

NC GreenPower is an independent, nonprofit organization established to improve North Carolina's environment through voluntary consumer contributions toward the production of renewable energy. The goal of NC GreenPower is to supplement the state's existing power supply with more green energy—electricity generated from renewable resources like the sun, wind and organic matter. The program accepts financial contributions from North Carolina citizens and businesses to help offset the cost to produce green energy. NC GreenPower differs from a Renewable Portfolio Standard (RPS) in that the RPS requires that electric utilities provide a certain level of renewable energy capacity in their generation mix. NC GreenPower is entirely voluntary, with the revenue going toward paying incremental costs of renewable energy generation. Also, because all power purchased through NC GreenPower is produced inside the state, the program provides local and statewide economic development benefits.

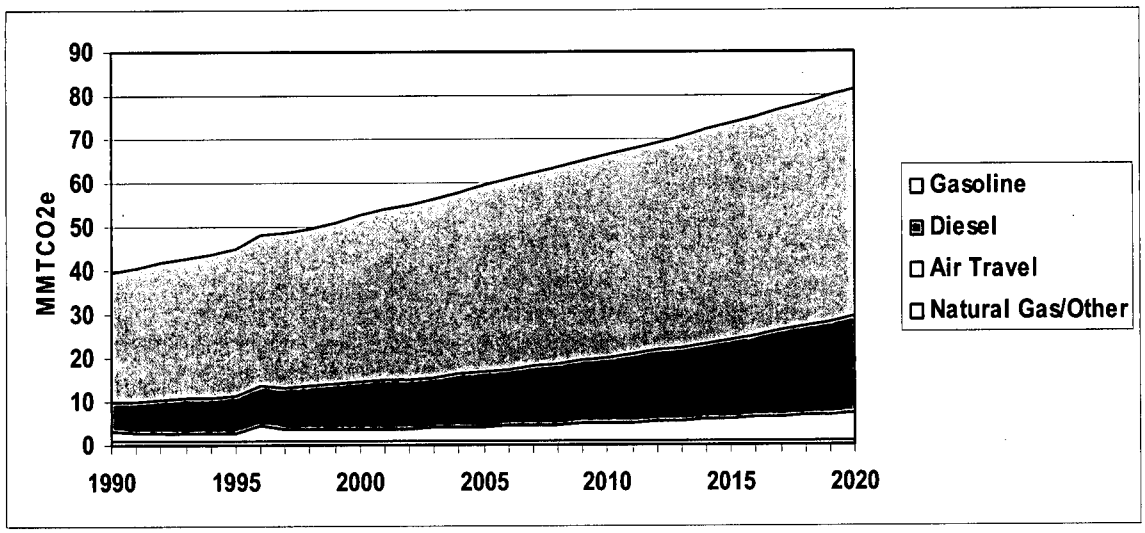
Chapter 5
Transportation and Land Use

Overview of GHG Emissions

The transportation sector is a major source of GHG emissions in North Carolina—currently accounting for 29% of the State's gross GHG emissions. Transportation emissions are determined by technologies, fuels, and activity rates. Activity rates, in turn, are determined in part by population, economic growth, and land use choices that affect the demand for transportation services. GHG emissions from the transportation sector totaled about 52.7 $MMtCO_2e$ in 2000.

Figure 5-1 shows historical and projected Transportation and Land Use (TLU) GHG emissions by fuel and source, and illustrates their rapid growth. TLU emissions are expected to more than double from 1990 from 2020. On-road vehicle miles traveled (VMT) are forecast to continue to grow faster than the population, and rapid growth in freight VMT is also expected. The high overall growth in transportation sector emissions suggests many opportunities and challenges for reducing North Carolina's GHG emissions.

Figure 5-1
Historical and Projected GHG Emissions from the Transportation and Land Use Sector, North Carolina, 1990 to 2020



Key Challenges and Opportunities

Options for reducing emissions from transportation fall into three categories:

1. Reducing GHG emissions per vehicle mile traveled;

2. Reducing the carbon intensity of fuels; and

3. Reducing activity rates, either absolutely or relative to the baseline. Policies may produce modal switches to lower-emission means of travel, and/or decrease the total amount of travel.

North Carolina has substantial opportunities to reduce emissions in each category:

- In North Carolina and in the nation as a whole, vehicle fuel efficiency has improved little since the late 1980s, yet many studies have documented the potential for substantial increases consistent with maintaining vehicle size and performance.

- The use of fuels with lower GHG emissions is growing and larger market penetration is possible.

- North Carolina also has taken steps to increase transit options and plan for growth that reduces emissions, but the state can absorb its rapid growth in development patterns that will produce far less travel, and far lower emissions than forecast.

Overview of Mitigation Recommendations and Estimated Impacts

The CAPAG recommends a set of 13 mitigation options for the Transportation and Land Use sector that offer the potential for major economic benefits and emissions savings. As summarized in Table 5-1, these mitigation recommendations come from each of the available reduction categories above, and could lead to emissions reductions from reference case projections of 25.5 $MMtCO_2e$ per year by 2020, cumulative savings of 232 $MMtCO_2e$ from 2008 through 2020, and net cost *savings* of over $4.3 billion to the North Carolina economy through the year 2020 on a net present value basis (NPV).[1] The weighted average cost of saved carbon from the mitigation options for which quantitative estimates of both costs and savings were prepared was -$19 per metric ton of CO_2 equivalent.

The estimated impacts of the individual mitigation options are shown in Table 5-1 below. The CAPAG mitigation recommendations described briefly here (and in more detail in Appendix G to this Report) result not only in significant emissions and costs savings, but offer a host of additional benefits as well. These benefits include (but are by no means limited to) reduced local air pollution, more livable, healthy communities, and increased transportation choices.

In order for the TLU mitigation options recommended by the CAPAG to yield the levels of savings described here, the options need to be implemented in a timely, aggressive, and thorough manner. To be most effective, the group of mitigation options aimed at VMT reductions and increased transportation choices (TLU-1a, Land Development Planning, and TLU-1b, Multi-Modal Transportation and Promotion) will require change at every level of government, and as such will be most effective with focused leadership by the State, including training, outreach, and technical assistance to local governments and businesses (either directly or via local governments). For example, TLU-1b, Multi-modal Transportation and Promotion, includes one of the empirically most powerful ways to reduce emissions, employer-based commute benefits.

[1] The net cost savings are based on fuel expenditures, operations, maintenance, and administrative costs, and amortized, incremental equipment costs. All NPV analyses here use a 5% real discount rate.

Among businesses that implement them, these are very popular and cost-effective. Yet for a variety of reasons, businesses implement these benefits at a much higher rate with government technical assistance.

Next, the State Clean Car program must clear several hurdles before North Carolina or any other state can adopt it, including EPA approval of the original California Clean Car Program (that other states can then opt into) and a court challenge to the underlying notion of regulation of GHG emissions from vehicles. If for any reason North Carolina is not able to implement the Clean Car Program, other options would need to play a larger role if the State is to meet its emissions reduction goals. For example, the mitigation options under the Rebates/Feebates Options Bundle (TLU-3b) could substantially improve fuel efficiency through market mechanisms and consumer labeling. Feebate proposals usually have two parts: 1) a fee on relatively high emissions vehicles; and 2) a rebate or tax credit on low emissions vehicles.

As a final example, Pay-As-You-Drive Insurance would require the State to not only allow insurance companies to offer customers a way to save each time a customer chooses to drive less, but also to promote that option, if the State is to see the levels of adoption analyzed here.

Most of the recommended mitigation options would produce substantial economic benefits for North Carolina. The sources, and calculations, of these benefits are detailed in Appendix G. Because the form of several of the recommendations leaves the State and its constituents substantial latitude in how to act to achieve the recommended goals, it was not possible to estimate financial costs and benefits for all options.

For example, TLU-1a recommends that the State's local jurisdictions develop growth plans. Given the substantial portion of forecast emissions growth driven by increasing driving, growing in more compact, mixed-use patterns is simply essential to meeting the State's emissions reduction targets. For the same reason, changing development patterns also offers the single largest potential emissions reduction from transportation. Each jurisdiction can develop its own approach to planning for growth, and because we cannot know which approach each will choose, we cannot estimate the cost for each, or, as a result, the likely total cost. In the case of TLU-1a, CCS reviewed experience in, and estimates for, growth planning in other states. With few exceptions, experience and forecasts across a wide variety of planning choices show *substantial* net cost savings from planned growth relative to the kind of growth now prevalent in North Carolina. North Carolina and its communities would likely save billions of dollars from shorter sewer lines, fewer needed new roads, and fewer new schools. But given the wide range of choices available to North Carolina communities under recommended TLU-1a, it is not possible to put a point estimate on the benefits that will likely be produced by those choices

The benefits from other recommended options were more straightforward to forecast. The technology required in TLU-5, tailpipe GHG standards for example, would more than pay for itself in reduced fuel consumption, while substantially reducing North Carolina's GHG emissions.

Cost Savings

Several of the TLU options (below) show higher estimated net savings than most other options both in and out of TLU. This subsection summarizes *briefly* the source of those estimates.

TLU-1b. Multi-Modal Transportation and Promotion

A wide variety of empirical experience suggests that the policies and investments listed in the Option Design and Implementation Mechanisms sections are likely to produce substantial net savings, as in the following four examples.

1. *Transit investments generally*

Nationally, transit produces net economic returns on investment: "For every $10 million invested, over $15 million is saved in transportation costs to both highway and transit users. These costs include operating costs, fuel costs, and congestion costs."[2]

At a high level, then, the benefits of the proposed investment in transit can be estimated as follows:

NC DOT budget:	$2.5 billion/year
13%	$325,000,000/year
× 1.5 savings multiplier	$487,500,000/year in savings
–cost of investment	$325,000,000/year
Total benefits	**$162,500,000/year**

This substantial return on investment is the basis for the cost savings number reported in the summary table. Without knowing more about how North Carolina will make its transit investments, it is not possible to do a finer-grained analysis. However, *the following examples suggest that the 1.5x savings multiplier may be conservative.* [Portions of the following sections dealing with a possible savings multiplier are italicized.]

2. *Transit fare initiatives*

Unlimited Access transit at the University of California-Los Angeles costs $810,000 a year, and has total benefits of $3,250,000 a year,[3] *a return on investment of more than 4x*. Similar programs at other universities show similar results.[4] The many educational institutions in North Carolina could see similar savings.

Universities are in some senses unique institutions, but the general types of challenges (especially demand for, and costs of providing, parking), and the types of benefits enjoyed in response to commute benefits programs, are equally available to businesses. A report on this topic notes:

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[2] Cambridge Systematics, Inc., *Public Transportation and the Nation's Economy: A Quantitative Analysis of Public Transportation's Economic Impact*, 1999.

[3] Jeffrey Brown, Daniel Hess, and Donald Shoup, "Fare-Free Public Transit at Universities: An Evaluation," *Journal of Planning Education and Research* (23:69–82), 2003.

[4] Jeffrey Brown, Daniel Hess & Donald Shoup, "Unlimited Access," *Transportation* 28:233–267, Kluwer, 2001.

> "Eco Passes also offer significant advantages for employers who offer free parking to all commuters, because those who shift from driving to transit will reduce the demand for employer-paid parking spaces. A survey of Silicon Valley commuters whose employers offer Eco Passes found that the solo-driver share fell from 76 percent before the passes were offered to 60 percent afterward. The transit mode share for commuting increased from 11 percent to 27 percent. These mode shifts reduced commuter parking demand by approximately 19 percent.
>
> "Given the high cost of constructing parking spaces in the Silicon Valley, *each $1 per year spent to buy Eco Passes can save between $23 and $333 on the capital cost* of required parking spaces."[5]

3. *Transit and non-SOV options information and promotion:* Per public dollar, a Transportation Management Organization (TMO) can *accommodate seven times as many commuters as new highway investment.*[6]

4. *TDM investments on the basis of avoided driving:* This policy is estimated to reduce VMT by 3,317,688,733 in 2012, and 3,970,779,011 in 2020. The current IRS-estimated cost of driving a mile in a personal vehicle is $0.485. At that rate, total savings will be

	2010	**2020** (constant $)
VMT reduced	$3,317,688,733	$3,970,779,011
@ $0.485 / VMT, Avoided costs =	$1.6 billion	$1.9 billion
–Cost of investment	$325,000,000	$325,000,000
Net savings	**$1.2 billion**	**$1.6 billion**

Thus, the estimated $162,500,000/year in total savings for this Option used for the summary table is very conservative.

TLU-3a. Surcharges to Raise Revenue

If, as in the above example, revenue is used to fund multi-modal options promotion that reduces VMT, then we can estimate net benefits as show in Table G-4.

Table G-4. Estimated benefits: using surcharge revenues to fund multi-modal options.

	2010	**2020 (constant $)**
VMT reduced	$1,850,000,000	$1,850,000,000
@ $0.485 / VMT, Avoided costs =	$ 897,250,000	$ 897,250,000
–Cost of investment	$ 37,000,000	$ 37,000,000
Net savings	**$ 860,250,000**	**$ 860,250,000**

If, in an effort to be conservative, we limit the savings to the 7× savings multiplier found in a study for Minnesota DOT,[7] then the net benefits fall, as indicated in Table G-5.

[5] *Id.*, p. 260.

[6] Minnesota Department of Transportation, Modal Options Identify Project, "Measurement and Evaluation," 2006

[7] Minnesota Department of Transportation, Modal Options Identify Project, "Measurement and Evaluation," 2006

Table G-5. Conservative estimate of benefits (used in Summary Table)

	2010	2020 (constant $)
Cost of investment	$37,000,000	$37,000,000
Avoided cost @ 7x investment	$259,000,000	$259,000,000
Net savings	**$222,000,000**	**$222,000,000**

We use this lower number in the summary table.

TLU-5. Tailpipe GHG Standards

A review of $/ton estimates prepared for the California Clean car-type regulation for California Air Resources Board (CARB), Northeast States for Coordinated Air Use Management (NESCAUM), and CCS produces an estimate of between $117 saved for each metric ton of CO_2e reduced at the high end, and roughly a third of that (~$38 saved for each ton) at the low end. We used the low end in an effort to be conservative. This figure takes into account not only the higher initial cost of the California Clean Car, but also the costs of financing that car. Both the higher costs and the savings from reduced fuel consumption would start immediately upon purchase, and CARB estimates that the net savings would begin immediately as well.

Table 5-1
CAPAG Recommended Mitigation Options and Results for the Transportation and Land Use Sector

	Mitigation Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2008–2020 (Million $)	Cost-Effectiveness ($/tCO$_2$e)	Level of Support*
		2010	2020	Total 2008–2020			
TLU-1a	Land Development Planning	2.6	8.0	58.2	Net savings		SMJ
TLU-1b	Multi-Modal Transportation and Promotion (formerly TLU-2)	3.7	5.8	52.4	–1,300	–25	UC
TLU-3a	Surcharges to Raise Revenue	1.2	2.2	15.7	–1,800	–117	SMJ
TLU-3b	Rebates/ "Feebates" to Change Fleet Mix	0	< 0.5	2.8	Not quantified	–40 to +10	SMJ
TLU-4	Truckstop Electrification	Included in TLU-8			Net savings		UC
TLU-5	Tailpipe GHG Standards	0	8.1	44.5	–1,690	–38	SMJ
TLU-6	Biofuels Bundle	1.9	4.5	35.4	Not quantified		UC
TLU-7	Procure Efficient Fleets	Included in TLU-6					UC
TLU-8	Idle Reduction/Elimination Policies	0.1	0.2	2.2	–6	–4	UC
TLU-9	Diesel Retrofits	0.3	2.2	13.5	Not quantified		UC
TLU-11	Pay-As-You Drive Insurance	2.3	5.3	42.0	Expected net savings		SMJ
TLU-12	Advanced Technology Incentives	Not quantified					UC

	Mitigation Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2008–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of Support*
		2010	2020	Total 2008–2020			
TLU-13	Buses – Clean Fuels	Included in TLU-6					UC
	SECTOR TOTAL AFTER ADJUSTING FOR OVERLAPS	11.1	25.5	232.3	–4,350	–19	
	REDUCTIONS FROM RECENT ACTIONS	0	0	0	0	0	
	SECTOR TOTAL PLUS RECENT POLICY ACTIONS	11.1	25.5	232.3	–4,350	–19	

* UC = unanimous consent (all agree), SMJ = super majority (at least 80% or more agree). TLU-2 was renamed TLU-1b because of its linkage to TLU-1a. There is no mitigation option TLU-10, because this catalog option was not advanced by the CAPAG.

Note that for TLU-5, the estimated emission reduction for each year from 2008 through 2020 was multiplied by the cost-effectiveness value of -$38/ton to estimate cost savings for each year, and then the cost savings for each year was discounted and summed to estimate the NPV. Thus, the cost-effectiveness value of -$38/ton cannot be replicated by dividing the cumulative cost savings by the cumulative emission reduction shown in this table.

Transportation and Land Use (TLU) Mitigation Option Descriptions

The Transportation and Land Use Sectors include emissions reduction opportunities related to reducing GHG emissions per miles of travel, reducing the carbon content of transportation fuels, and using transportation and land use policy to reduce the need to travel by high-emitting modes. Additional detail on each of the options summarized below can be found in Appendix G.

TLU-1a. Land Development Planning

The CAPAG recommends that North Carolina promote land planning and development that supports conservation of high quality natural and cultural resources and supports more compact development, and as a result reduces growth in driving and emissions. Do so by supporting and promoting private and public planning and development practices, including infrastructure provision, that reduce the number, length, or travel mode of trips made in North Carolina.

The suggested statewide goal is to reduce projected increase in VMT by 10% statewide by 2020. (Value was developed after review of targets in several other states, and an assessment by the group of the ability to meet the target.)

Meeting the goal will require diverse implementation tools. Providing many options, statutory changes, and program assistance for smaller communities will be essential.

Land Use and Development Legislation to Require Adoption of a Growth Plan

- *Each municipality and county shall develop a land use and development plan.*

  The plan should designate planned growth areas and natural resource areas within that jurisdiction and any extraterritorial jurisdiction for a planning horizon of at least 25 years. The land use and development plan should include standards and criteria for conservation area and/or urban service area designations to accommodate a minimum 20-year growth forecast agreed upon by the each county and municipality; establish development and conservation goals; recognize important natural and human resources; and, express appropriate policies, practices and strategies to implement these goals. Local planning programs should include appropriate public involvement processes to achieve consensus on the development and conservation vision for the community.

- *Require and support integration of transportation with land use plans.*

  Maryland, Minnesota, and Denver, CO, as well as the non-profit Triangle Land Conservancy have developed "greenprints" of areas that have old-growth forests, productive agricultural lands, water supply watersheds, historic sites or other critical and irreplaceable resources. Adding this as a required element of all transportation plans would be a simple and meaningful step that would greatly enhance the effect and benefits of NC GS 136-66.2 without requiring new zoning or regulatory powers. The November, 2004 passage of tax increment financing legislation demonstrates that North Carolina can and does make room for new ideas that help achieve economic development goals in concert with infill development objectives. The N.C. Small Town Economic Development (NCSTEP) initiative created grant funds that are being used in 33 communities to plan for growth and development in a way that will help those communities benefit from growth and minimize negative impacts.

Regulatory incentives such as withholding transportation funds for non-compliance have worked in Tennessee and should be considered in North Carolina as well.

TLU-1b. Multi-Modal Transportation and Promotion

The CAPAG recommends that the State work with its constituents to shift passenger transportation mode choice to lower emitting choices. Ensure that transportation is integrated with and appropriately serves land-use development plans (developed under TLU-1a). Implement the North Carolina transportation plan allocation of 13% of state transportation spending to transit.

Implement policies that increase use of public transportation, producing a shift to lower emitting mode choices, by the following policies:

- Improve Transit Service (frequency, convenience, quality).
- Expand Transit Infrastructure (rail, bus, Bus Rapid Transit).

- Focus new development on transit-served corridors (Transit-Oriented Development).
- Expand Transit Marketing and Promotion (including tax-free and employer-paid Commuter Benefits, and Parking Cash Out).
- Expand Transportation System Management and Design, which speeds both transit and other traffic.
- Improve bike and pedestrian infrastructure both as feeders and as stand-alone modes.
- Many programs are in place and are therefore immediately expandable/implementable. Enhancement and continuation can begin short-term. These implementation mechanisms include:
  - Aggressively support and aid the creation of Regional Transportation Districts (RTDs). RTDs can sell bonds for capital projects, and member governments can levy taxes for operation and maintenance subject to voter approval.
  - Make planning and funding rules more flexible to allow transit operators to provide service to places outside of their municipal jurisdictions.
  - Abolish or reduce minimum parking requirements in zoning codes, and allow localities to establish parking maximums.
  - Create a best practice guide and recognize developers who adhere to best practice when designing and locating new private and public development.
  - Require planning to extend beyond 5 years (20 years recommended) for all systems.
  - Create incentives or require the purchase of biodiesel fuel (minimum: B20) as a part of all public bus replacement programs. Conover has already done so with great results.
  - Location of State Facilities—Locate state facilities near transit facilities. Where and when appropriate/possible all state government offices should be located downtown. Similarly, provide transit to serve concentrations of state employees.[8]
  - State Targeting of Infrastructure Investments—Legislatively appropriated capital outlay funds, state public revolving loan fund, and other state-funded infrastructure initiatives should be used for projects that encourage walkable and traditional communities, and are supportive of transit.
  - Make maintenance of infrastructure a priority—Fix it First. Revise any state infrastructure programs; transportation, water, sewer, that fund new systems but not maintenance or upgrades for existing systems.
  - Replace "average cost pricing" for utilities services with rate structures that charge full marginal costs for both new infrastructure and for water, sewer, electricity, and telephone service delivery.
  - Fund the transportation-related programs in this mitigation option with monies generated by other mitigation options such as feebates and/or gas tax.

[8] This is an Executive Order from North Carolina Governor James Holshouser.

TLU-3a. Surcharges to Raise Revenue

The CAPAG recommends that the State vary motor vehicle registration fees by vehicle emissions to provide a surcharge on higher emitting vehicles.

This surcharge would raise funds for State of North Carolina to support transportation-related projects that reduce GHG. It would raise these funds through a mechanism that is directly tied to a significant source of GHG emissions from cars and trucks. It is not envisioned that the scale of the surcharge would affect the fleet mix; the goal of this policy is revenue-raising that is tied to emissions.

- 5.1 million North Carolina LDV registrations per year at an average of $7.25 per vehicle would produce $37 million per year for programs to reduce emissions from travel.
- The most efficient regionally funded regional commuter programs can reduce VMT for a cost of 2 cents/mile. Most regional commuter programs cost more per mile. On the other hand, few are as well funded as this proposal, and there are almost certainly economies of scale and scope.
- $37 million per year times $0.02 per mile equals 1,850,000,000 VMT = 2% of total statewide VMT; 3% of total urban LDV VMT.

TLU–3b. Rebates/ Feebates to Change Fleet Mix

The CAPAG recommends that the State charge a sliding scale of fees and rebates for new light-duty vehicles based on their emissions of greenhouse gases and/or other measures of a vehicle's environmental impacts. This will provide an incentive for manufacturers to sell cost-effective efficiency technologies, and for consumers to buy lower-emitting vehicles by:

- having price signals reflect emissions levels and thus have emissions levels more directly enter buying decisions.
- sending a signal to manufacturers to produce increasingly low-emitting vehicles for the market.

The revenue should be used to create a dedicated revenue stream for promotion of low emitting or no emitting GHG transportation alternatives e.g., hybrid tax credits, transit infrastructure. In addition:

- Emissions could be considered relative to other vehicles within each class or across classes based on their design variations.
- The rebate/ feebate could be set as a multiplier for an excise tax so that the fee or rebate is determined not only by the emissions rate of the vehicle but by its price as well.

- Generally the rebate/ feebate design needs to be simple, minimize the number of pivot points, be well-documented, and be designed to maximize consumer attention.

A wide variety of economics literature finds that vehicle buyers do not buy all the efficiency technology that is cost-effective, taking into account the net present value of both the fuel savings and the additional technology cost. Feebate analyses find that the fuel savings that result from a feebate program would pay for additional costs, producing net cost savings:

> "The reduction in consumer surplus is more than compensated for by unvalued fuel savings that are realized. The benefits are positive for all rates up to $1000 but marginal costs begin to outweigh benefits between $500 and $1000. Adopting two or more classes reduces the benefits significantly while creating a relative subsidy for larger vehicles."

As a result: Net benefits range from $40 per ton for a low feebate, to $10 per ton for a high feebate.

TLU-4. Truckstop–and Places Where Trucks Stop–Electrification

The CAPAG recommends that North Carolina reduce idling-induced emissions from heavy-duty diesel trucks by providing—or helping the market to provide—electrical hook-ups to power heating, cooling, and other needs while stopped.

North Carolina should analyze existing pilot projects at major truck stops on interstate highways (principally, I-40 and I-85) and initiate other efforts at other places where truck traffic is high; then, progress to include all major truck stops statewide with at least one multi-unit electrified stop in each of the 17 urban areas in North Carolina.

North Carolina has several TSE pilots in place. While programs are in discussion there are no policies or laws to enforce participation.

TLU-5. Tailpipe GHG Standards

The CAPAG recommends that North Carolina join with the 13 other states that have adopted the State Clean Car Program to reduce emissions of GHGs from vehicle operation.[9]

TLU-5 would use California Clean Car standards for cars and light trucks to reduce GHG emissions. California standards require GHG emissions reductions of about 30 % from new vehicles, phased in from 2009 to 2016, through a variety of means.[10] Other Clean Car Program elements include standards requiring reductions in smog- and soot-forming pollutants, and promoting introduction of very low-emitting technologies into new vehicles.

[9] Also known as the "Pavley" standards (after Assemblywoman Fran Pavley who introduced the legislation) or "California GHG emission standards."

[10] For detailed information see: http://www.arb.ca.gov/cc/ccms/ccms.htm

The General Assembly could enact legislation in 2009, at the earliest, unless tied to a 2007 bill carried over to 2008 so that North Carolina can implement the California standards.[11]

TLU-6. Biofuels Bundle

The CAPAG recommends that the State work to increase market penetration of biofuels in North Carolina by a mixture of policies (voluntary and/or mandatory) to achieve feasible goals—offsetting fossil fuel use (gasoline) with production and use of starch-based and cellulosic ethanol.

Replacing gasoline with ethanol can reduce GHG's to the extent that the ethanol is produced with lower GHG content. Biodiesel has a lower GHG content than fossil diesel, so using biodiesel instead of fossil diesel reduces GHG emissions.

This option is linked with policy options AFW-2, Biodiesel Production, and AFW-6, Policies to Promote Ethanol Production. This option seeks to develop the demand for biofuels, whether produced locally or out-of-state. (Options AFW-2 and AFW-6 pursue the GHG benefits achievable beyond TLU options by promoting in-state production of ethanol and biodiesel using feedstocks and production methods with greater GHG benefits than the likely business-as-usual national market production methods, e.g., conventional starch-based ethanol.)

The goals for this policy should be phased in utilizing biofuels to replace the specified percentages of gasoline and diesel consumed for transportation throughout North Carolina by the specified years, as shown under Goal Levels, below. The goals of this policy can be achieved through a combination of a renewable fuels standards, financial incentives, outreach, and market-based mechanisms.

Goal levels and timing for biofuels implementation.

Phase	Year	Percentage of Gasoline to be Replaced by Biofuels	Percentage of Diesel to be Replaced by Biofuels
1	2010	10% (E10 equivalent)	5% (B5 equivalent)
2	2015	15% (E15 equivalent)	10% (B10 equivalent)
3	2020	20% (E20 equivalent)	15% (B15 equivalent)
4	2025	25% (E25 equivalent)	20% (B20 equivalent)

The CAPAG recommends pursuing these goals through the following mechanisms:

- Pursue DOE and State funding for more alternative fuel pumps throughout the State and for introducing appropriate infrastructure throughout the State. Some federal tax incentives currently exist for the purchase of alternative fuel vehicles. When the federal incentives expire, examine the feasibility/need to continue such incentives for alternative fuel vehicles.

[11] The California standards currently are being litigated, and timing may be affected as a result. Recent court decisions have found that CO2 can be a pollutant under the Clean Air Act (CAA). Many observers see this as clearing the way for the required EPA waiver under the CAA.

- Reduce or eliminate the motor fuels tax on biodiesel and ethanol (E85). Develop a system to provide for monthly credit for biodiesel and E85 blended fuel that would be equivalent to the state motor fuels tax owed on the biofuels portion of the fuel blend. (This could follow in the wake of elimination of tax on "home brew" biodiesel by 2007 legislature.)

  Monthly tax credits would be claimed on the same form (Biodiesel and Fuel Alcohol Providers Form) marketers currently file with the North Carolina Department of Revenue (DOR) Motor Fuel Tax Division to pay fuel tax. This would reduce pump price of Biofuels as marketers would pass most of the credit on to consumers to be competitive. Credits could be paid out of General State Revenues, DOT highway funds. Credit would be revenue neutral as it would be equal to the tax that would have been paid by marketers for biofuel portion of blend.

- Develop a $0.25/gallon credit for biodiesel and ethanol use in North Carolina vehicles.

  As above, the tax credit would be claimed on the DOR Biodiesel and Fuel Alcohol Providers Form. Similarly, this would reduce price of Biofuels as marketers pass the credit on to consumers in order to be competitive. General State Revenues, or DOT highway funds could pay for the credit. Unlike above, this credit would not be revenue neutral as the state would be providing incentive for fuel sold to non-taxable entities (local and state government) as well as sales to taxable entities. However, only the biofuel portion of blended fuel would be eligible for 25 cent credit. For example a B20 blend would get a 5 cent credit.

- Create a tax credit for biodiesel producers.
- Develop a mandated Renewable Fuel Standard (RFS), corresponding to the penetration rates listed above. The RFS should include a cost trigger, so that if the cost of alternative fuels exceeds conventional fuels by more than a specified amount, the RFS would be temporarily removed. The cost trigger should be based on costs over a period of time, and not spot prices. Additionally, production issues should be included in the trigger, such as water use in growing corn (or other crops) for the biofuels, such that the production of the biofuels does not increase GHG emissions or cause other resource problems.

TLU-7. Procure Efficient Fleets

The CAPAG recommends that the State reduce GHGs by increasing the efficiency of vehicle fleets generally, beginning with government lead by example. Also increase fleet use of alternative fuels.

- Increase government fleet use of low-GHG fuels and more efficient vehicles to reduce greenhouse gas emissions from fleets. In addition to CO_2 reductions, this would reduce emissions affecting ozone, sulfur, and carbon monoxide loadings.

- Set statewide GHG reduction targets for fleets phased in over period of probably 8-10 years to allow fleet turnover to absorb most of the costs of replacing existing fleets. Other measures regarding more frequent maintenance and part specifications could be phased in much faster.

TLU-8. Idle Reduction / Elimination Policies

The CAPAG recommends that the State implement state policies, and support the development of local policies, to reduce hours of operation and thus emissions from idling trucks and buses (principally), perhaps off-road engines as well.

These would reduce greenhouse gas emissions from heavy vehicles and reinforce Truck Stop Electrification (TSE).

This would require working with trucking groups, truck stops, and places where trucks stop as well as with government to formulate an agreeable policy approach, phasing schedule, and legislative content.

About 15 states and a number of local governments have adopted anti-idling legislation.[12] More are sure to follow or are already being discussed at some level. Toronto has had a law in place since 1996. Many North Carolina counties and the State Board of Education (Policy No. EEO-M-003) have adopted school bus idling policies already.[13] The Clean School Bus USA program (USEPA) should also be consulted.[14]

TLU-9. Diesel Retrofits / Retirement

The CAPAG recommends that the State reduce diesel emissions from older diesel engine/emission systems through a broad retrofit and/or retirement program. Create incentives and encourage retrofits through a combination of funding and education/promotion.

This policy would reduce children's exposure to diesel emissions by retrofitting school buses in North Carolina with diesel oxidation catalyst (DOC) control devices, and/or diesel particulate filters, which have the auxiliary benefit of reducing some GHGs and carbon black.

Beyond school buses, the CAPAG recommends that the state speed retirement and/or retrofit of all older diesels through information and incentives.

- **Utilize various funding mechanisms** to purchase DOC pollution control devices and/or particulate traps for school buses that are not equipped with pollution control devices.
- **Provide information and education:** An information and education component is needed to provide truck and bus owners, school districts, and municipal organizations with information regarding the significant emissions reductions that could be achieved by retrofitting or retiring certain truck or bus engines with high annual emissions and replacing them with

[12] See http://atri-online.org/research/idling/Cab%20Card%20July%202006.pdf

[13] See http://www.ncbussafety.org/idling.html

[14] See http://www.epa.gov/cleanschoolbus/

vehicles meeting the new emissions standards. Provide information on potential funding partners, grants, or loans available from a number of organizations for this purpose.

- **Develop funding mechanisms or incentives:** Develop a loan or grant program allowing truck owners to accelerate new vehicle purchases or to apply retrofit technologies to their fleets.

Currently in North Carolina, there is an ongoing effort to retrofit school buses across the State with diesel pollution control devices. An estimated 15% of the school buses in the State are already equipped with some type of pollution control device. Sources of funding include Federal and State grants, local funding and gifts from private industry. The primary purpose of these diesel pollution control devices is to reduce particulate matter.

Legislation currently under consideration, HB 1912: School Bus Retrofits in Nonattainment Areas, addresses school bus retrofits.

TLU-11. Pay-As-You-Drive Insurance

The CAPAG recommends that the State use Pay-As-You-Drive (PAYD) insurance pricing to convert a portion of insurance to a variable cost with respect to vehicle travel, so premiums are directly related to mileage. PAYD makes insurance more actuarially accurate and allows motorists to save money when they reduce their mileage. The less you drive the more you save.

Proposal would require insurance companies to offer PAYD as part of their menu of insurance choices in North Carolina. A pilot project could be implemented first on a small scale as soon as possible. Option design is to have full North Carolina light-duty fleet PAYD coverage by 2020.

TLU-12. Advanced Technology Incentives

Technology will play a vital role in dramatically reducing carbon emissions from the cars of the future. Fuel cells, plug-in hybrid, low weight carbon-fiber bodies, and other technologies will require research, development, and commercialization. The CAPAG recommends that because of its strong research university and both its high-tech and auto parts manufacturing, that North Carolina (especially through the Department of Commerce) encourage advanced automobile technology research and recruit the new generation of manufacturers.

Studies can evaluate if there is an economic opportunity around the development and commercialization of advanced technology vehicles and suggest possible models for the Department of Commerce to take advantage of such opportunities.

The goals of this policy include:

- Enable North Carolina's economy to establish itself in the research, development, and commercialization of advanced automotive technologies.

- Grow North Carolina's capacity to recruit sustainable industry.

TLU-13. Buses – Clean Fuels

The CAPAG recommends that TLU-7 (procure efficient fleets) also include transit bus fleets.

Chapter 6
Agriculture, Forestry, and Waste Management

Overview of GHG Emissions

The agriculture, forestry, and waste management (AFW) sectors are directly responsible for a small amount of North Carolina's current greenhouse gas (GHG) emissions. For agriculture, net emissions were 11.0 million metric tons (MMt) of carbon dioxide equivalent (CO_2e) in 2000. Agricultural emissions include methane (CH_4) and nitrous oxide (N_2O) emissions from enteric fermentation, manure management, agriculture soils, and agriculture residue burning. As shown in Figure 6-1, emissions from agricultural soils and manure management in cattle account for the largest portions of agricultural emissions. The agricultural soils category includes N_2O emissions resulting from activities that increase nitrogen in the soil, including fertilizer (synthetic, organic, and livestock) application and production of nitrogen-fixing crops. Agricultural residue burning emissions are too small to show up in Figure 6-1.

Note that, in keeping with EPA methods and international reporting conventions, the inventory and forecast covers anthropogenic sources of GHGs. There could be some natural sources of GHGs that are not represented in the inventory and forecast; however these are not addressed in the CAPAG process. In the forestry sector, all emissions are treated as anthropogenic; since all of the State's forests are managed in some way (GHG reporting conventions are to treat all managed forests as anthropogenic sources). Sources such as carbon dioxide from forest fires and decomposing biomass are captured within the inventory and forecast (as part of the carbon stock modeling performed by the US Forest Service). However, methane emissions from anaerobic decomposition of biomass in forests are not currently captured due to a lack of data.

The contributions from agricultural soils and manure management have grown significantly since 1990, and they are projected to contribute 90% of agricultural emissions by 2020. Emissions from enteric fermentation have stayed the same since 1990 and are projected to stay relatively constant until 2020. GHG emissions from agricultural burning are estimated to continue to contribute a very small amount to the agricultural sector emissions.

Forestland emissions refer to the net carbon dioxide (CO_2) flux[1] from forested lands in North Carolina, which account for about 56% of the state's land area. As shown in Table 6-1, US Forest Service (USFS) data suggest that North Carolina forests sequestered an average of 23.7 $MMtCO_2e$ per year from 1987 to 1997. The CO_2 is sequestered in forest carbon pools such as live trees, debris on the forest floor, and forest soils, as well as in harvested wood products (e.g., furniture and lumber) and the landfilling of forest products. The data show an accumulation of carbon in each of the forest carbon pools during this period.[2] These rates of sequestration are assumed to remain constant through 2020.

[1] "Flux" refers to both emissions of CO_2 to the atmosphere and removal (sinks) of CO_2 from the atmosphere.

[2] This is not to say that the dead carbon pools (e.g., standing dead, forest floor) are sequestering carbon directly from the atmosphere. These pools accumulate carbon from trees/biomass that transition from a live carbon pool to a dead carbon pool.

Figure 6-1. Historical and projected GHG emissions from the Agriculture Sector, North Carolina, 1990–2020

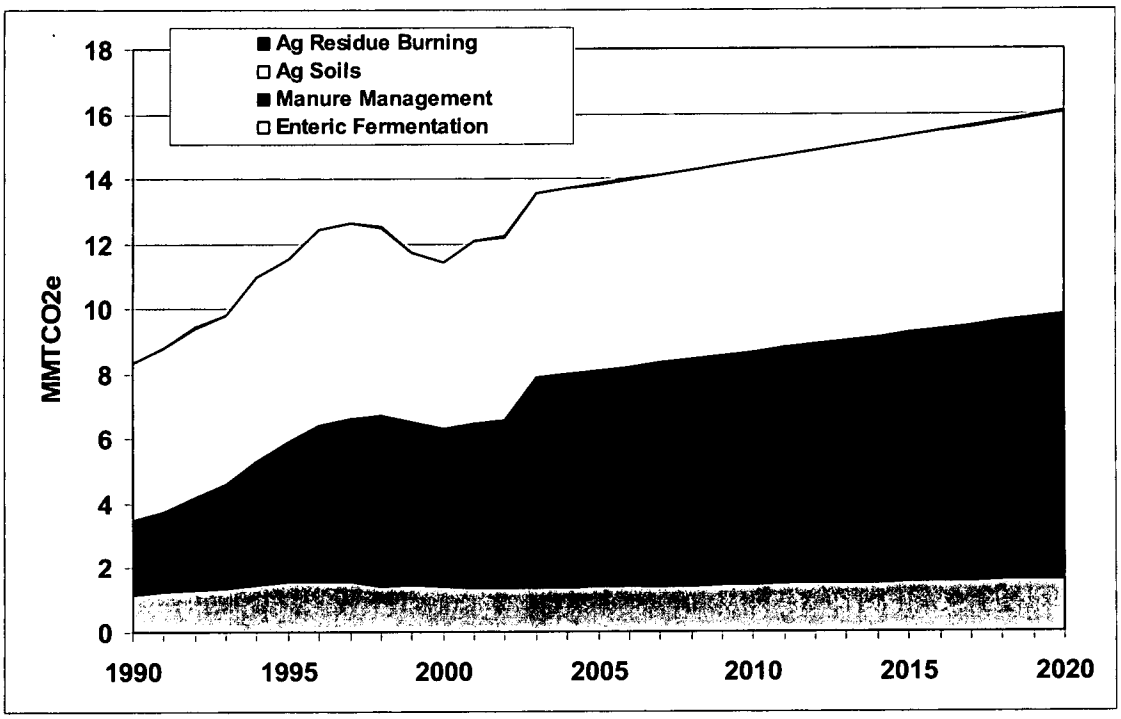


Table 6-1. GHG emissions (sinks) from the Forestry Sector

Forest Carbon Pool	1990–2020* $MMtCO_2e$
Live and dead-standing trees and understory	–6.9
Forest floor and coarse woody debris	–0.8
Soils	–3.1
Harvested wood products and landfills	–13
Total	**–23.7**

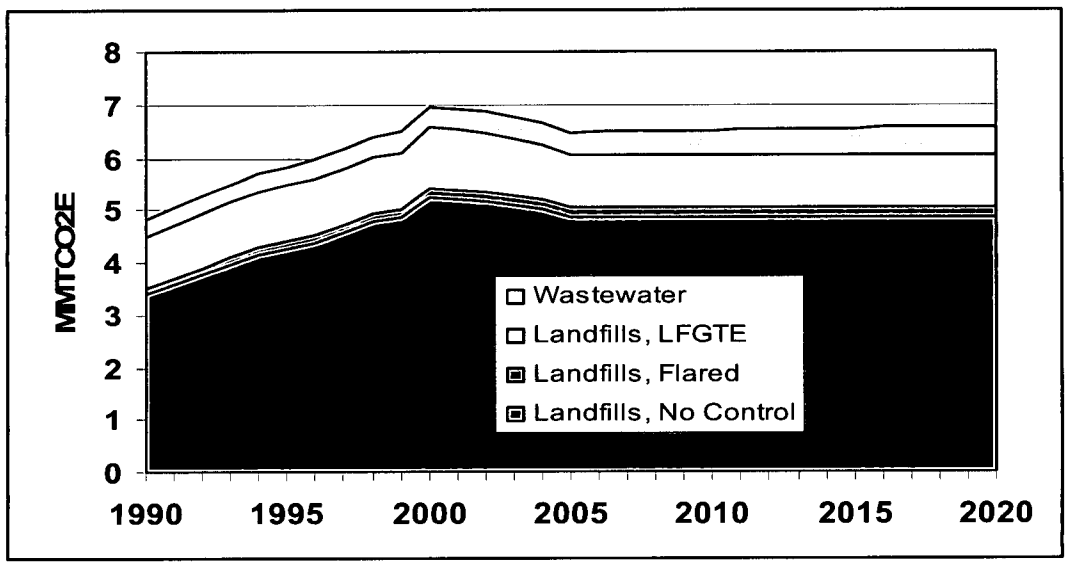
* Based on USFS data from 1983–1997.

Figure 6-2 shows estimated historical and projected emissions from the management and treatment of solid wastes and wastewater. Emissions from waste management consist largely of CH_4 emitted from landfills, while emissions from wastewater treatment include both CH_4 and N_2O. Landfill emissions are broken down into three subsectors: uncontrolled landfills (no CH_4 collection or control), flared landfills (CH_4 collected and flared), and landfill gas to energy (LFGTE) landfills (CH_4 collected and used as an energy source). Overall, the waste management sector accounts for less than 4% of North Carolina's total gross emissions per year from 1990 through 2020.

Opportunities for GHG mitigation in the AFW sector involve measures that can reduce emissions within the sector or reduce emissions in other sectors. For example, production of liquid biomass fuels can offset emissions in the transportation sector, while biomass energy can

reduce emissions in the energy supply (ES) or residential, commercial, and industrial (RCI) sectors. Similarly, actions that promote solid waste recycling can reduce emissions within the sector (future landfill CH_4), as well as emissions associated with the production of recycled products (recycled products often require less energy to produce than similar products from raw materials).

Figure 6-2. Estimated historical and projected emissions from waste and wastewater management in North Carolina



The following are primary opportunities for GHG mitigation.

- *Control and utilization of CH_4* —Methane emissions from manure management can be reduced through the use of anaerobic digesters or other technology. Methane can also be collected from landfills. The CH_4 captured can then be used to create electricity, steam, or heat to offset fossil fuel use.

- *Protection of forest and agricultural land from conversion to developed use*—By protecting these areas from development, the carbon in above-ground biomass and below-ground soil organic carbon can be maintained and additional emissions of CO_2e to the atmosphere can be avoided. Indirectly, these measures also support the objectives of "smart" development by helping to direct more efficient development patterns (see TLU-1a).

- *Beneficial use of forest and agricultural biomass*—Expanded use of biomass energy from residue removed from forested areas during treatments to reduce fire risk, crop residues, or purpose-grown crops can achieve GHG benefits by offsetting fossil fuel consumption (to produce either electricity or heat/steam).

- *Production of renewable fuels*—Production of renewable fuels, such as ethanol from crops, crop residue, forestry residue, or municipal solid waste, and biodiesel from crop

seed oils can produce significant reductions when they are used to offset consumption of fossil fuels (e.g., gasoline and diesel in the Transportation and Land Use (TLU) and RCI sectors). This is particularly true when these fuels are produced using processes and/or feedstocks that emit much lower GHG emissions than those from conventional sources.

- *Enhancement of forest carbon sinks*—Through programs that restore forests on lands that are currently not forested or under-stocked, additional CO_2 can be sequestered and stored in forest biomass. Similarly, in urban settings, expansion and maintenance of urban forests can increase sequestration and reduce energy consumption in buildings through shading and wind protection.

- *Retention of agricultural soil carbon*— Implement programs that incentivize growers to utilize cultivation practices that build soil carbon. By building soil carbon, CO_2 is sequestered from the atmosphere. Some cultivation practices also require the use of lower amounts of fossil fuels which further lowers GHG emissions.

- *Expansion of recycling infrastructure*—Increase the quantity of materials recovered for recycling with specific attention given to materials with the greatest ability to reduce energy consumption during the manufacturing process and to materials that may be used as a fuel source.

Key Challenges and Opportunities

In the agricultural sector, options to promote biodiesel and ethanol production were found to offer substantial GHG reduction potential with an estimated reduction of 7.7 $MMtCO_2e$ by 2020 (combined benefit of Options AFW-2 and AFW-6). This is the benefit from in-state production using North Carolina grown feedstocks and/or lower GHG production methods. The benefit is incremental to the benefit achieved via the renewable fuels standards incorporated in TLU-6. The benefits for both biodiesel and ethanol are based on production methods and feedstocks that have lower GHG emissions than conventional processes. For ethanol, this means processes that achieve much better GHG reductions than the production from conventional starch-based ethanol (the benefits of using ethanol from starch-based production are already accounted for under TLU-6). These processes could include cellulosic hydrolysis, biomass gasification combined with biofuels production, or alternative starch-based production methods (fermentation processes fueled by renewable fuels). Feedstocks for the fiber needed by this mitigation option could come from crop residue, forestry biomass, animal waste, and municipal solid waste. A major challenge for the success of AFW-6 is the production of a viable commercial-scale cellulosic ethanol industry by 2015.

For biodiesel, crop production should be promoted that results in significantly better vegetable oil yields than soybean oil, which is currently the most prominent feedstock in the United States. Candidates include vegetable oil crops like canola, sunflower, or jatropha that have much higher yields or emerging technologies like algal oil production.

The challenges for biofuels in North Carolina will be to identify and promote appropriate feedstocks for the production of these fuels. Limited analysis by the Climate Action Plan

Advisory Group (CAPAG) suggests that sufficient feedstock for cellulosic ethanol is available to meet the mitigation option's objectives. There is limited capacity within the state for crop production to support all of the biodiesel production envisioned by the CAPAG's recommendation without the use of cropland that is currently used for other purposes. Hence, careful study is needed to identify available croplands and appropriate crops for vegetable oil production. Funding and/or incentives will be needed to support the development of alternative biofuels production capacity, including research and development on emerging feedstocks and scale-up of production facilities.

As shown in the mitigation option descriptions in Appendix H, the implementation mechanisms developed for the agricultural sector should focus on methods that avoid conflict with potential future market-based GHG reduction programs. These include GHG credits that could be generated in the agricultural sector through renewable fuels projects, soil carbon projects, and possibly other project types. New regulations that mandate emission reductions or specific agricultural practices could limit North Carolina agriculture from taking part in emerging carbon markets. Implementation mechanisms that are incentive and education based can avoid these conflicts.

Combining the agricultural and forestry land preservation options (AFW-4a and AFW-4b), 4.6 $MMtCO_2e$/year in GHG emissions is estimated to be saved in 2020. To achieve these reductions, the state will need to work closely with local planning agencies, land owners, and nongovernmental organizations to identify lands suitable for acquisition/conservation easements and funding mechanisms. Another benefit to these options, which was not quantified, is the reduction in vehicle-miles traveled due to more efficient development patterns (see TLU-1a).

Within the forestry sector, afforestation of non-forested lands (AFW-8) has the potential to deliver an additional 2.4 $MMtCO_2e$/year in 2020. The mitigation option aims at afforestation of lands that are primarily agricultural today. Hence, a key uncertainty in the implementation of this option is whether or not landowners will be willing to accept a new form of land management that has a different investment structure than agriculture (e.g., different than the Conservation Reserve Program under the US Farm Bill).

Expanded Use of Forest Biomass and Better Forest Management (AFW-9&10) are estimated to deliver 5.9 $MMtCO_2e$/year in GHG emissions savings in 2020. The emission savings are offered through additional carbon sequestration in forest ecosystems and durable wood products and through fossil fuel offsets from forest-based energy (GHG benefits of fossil fuel offsets are accounted for in AFW-6 and in the RCI and ES sectors). Success will be achieved through close cooperation between North Carolina, federal agencies (USFS), and private industry to identify biomass resources and effective end uses for the resources.

Also in the forestry sector, AFW-13 (Urban Forestry Measures) has significant potential for GHG benefits (4.3 $MMtCO_2e$/year by 2020). This is a combination of direct benefits (CO_2 sequestration in urban trees) and indirect benefits (lower energy consumption in buildings through shading and wind protection) with the indirect benefits yielding most of the benefit. The biggest challenge confronting the success of this mitigation option is in containing the costs associated with tree planting and maintenance programs. For example, the costs of tree planting

programs can vary substantially depending on whether the labor is paid or unpaid. Hence, strong relationships between all of the related parties are needed (State Department of Forestry, utilities, communities, nongovernment organizations). Also, the ability to implement these programs in smaller and newer communities on previously cleared land may be limited by the administrative capacity of these communities.

Landfill Methane and Biogas Energy Programs (AFW-11) offers the potential for emission savings directly by controlling landfill CH_4 emissions and indirectly through offsetting fossil fuel use (2.9 $MMtCO_2e$/year by 2020). Challenges of this mitigation option include the location of landfills in very rural areas resulting in a lack of viable local end users, and the possible treatment as a regulated utility can also prevent landfill gas-to-energy projects from being developed. An additional benefit of this option includes reducing landfill gas emissions of volatile organic compounds, including some that are hazardous air pollutants.

Through implementation of AFW-12, additional GHG reductions can be achieved by increasing waste recycling programs in the State (0.5 $MMtCO_2e$/year). As with the landfill CH_4 option above, emission reductions are very cost-effective ($1/$MtCO_2e$ estimated for each of these options. Through recycling, emissions are reduced through avoided future landfill CH_4 and through lower energy consumption used in the production of recycled products versus products made from raw materials.

Overview of Mitigation Option Recommendations and Estimated Impacts

The CAPAG recommends a set of 12 mitigation options for the AFW sector that offer the potential for major emissions savings. As summarized in Table 6-2, the AFW mitigation option recommendations could lead to emissions reductions from reference case projections of 29 $MMtCO_2e$/year by 2020, cumulative reductions of around 213 $MMtCO_2e$ from 2007 through 2020, and a net cost of approximately $227 million through the year 2020 on a net present value (NPV) basis.[3] The weighted average cost of saved carbon is estimated at $1/$MtCO_2e$. The CAPAG believes that this represents an extremely low cost to the North Carolina economy in implementing this package of options.

The CAPAG mitigation option recommendations described briefly here (and in more detail in Appendix H) result not only in significant emissions savings, but offer a host of additional benefits as well. These benefits include, but are by no means limited to 1) support of North Carolina agricultural producers in the production of biofuels crops, development of new markets for agricultural byproducts, and training/outreach covering energy production, organic farming, and other areas; 2) creation of jobs in the biomass energy and liquid biofuels feedstock/production industries; 3) healthier forests with lower fire risk through the development of markets for forestry residue; and 4) research and development work to be conducted by North Carolina universities and other in-state organizations to support many of the options for this sector.

[3] The net cost savings are based on fuel expenditures, operations, maintenance, and administrative costs, and amortized, incremental equipment costs. All NPV analyses here use a 5% real discount rate.

Table 6-2. CAPAG Recommended Mitigation Options and Results for the Agriculture, Forestry, and Waste Management Sector

	Mitigation Option Name	GHG Reductions ($MMtCO_2e$)			Net Present Value 2007–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of Support*
		2010	2020	Total 2007-2020			
AFW-1	Manure Digesters & Energy Utilization	0.2	0.9	6.4	199	31	UC
AFW-2	Biodiesel Production (incentives for feedstocks and production plants)	0.2	0.8	5.1	286	56	UC
AFW-3	Soil Carbon Management (including organic production methods incentives)	0.2	0.2	3.0	–16	–5	UC
AFW-4a	Preservation of Working Land – Agricultural Land	0.2	0.3	2.6	290	114	UC
AFW-4b	Preservation of Working Land – Forest Land (formerly AFW-7)	1.7	4.3	36	112	3	UC
AFW-5	Agricultural Biomass Feedstocks for Electricity or Steam Production	0.009	0.02	0.2	10	54	UC
AFW-6	Policies to Promote Ethanol Production	0.9	6.9	38	200	5	UC
AFW-7	*Moved to AFW 4a*						
AFW-8	Afforestation and/or Restoration of Non-forested Lands	0.2	2.4	15	128	9	UC
AFW-9&10	Expanded Use of Forest Biomass and Better Forest Management	1.5	5.9	48	–639	–13	UC
AFW-11	Landfill Methane and Biogas Energy Programs	1.1	2.9	20	23	1	UC
AFW-12	Increased Recycling Infrastructure and Collection	0.2	0.5	4.1	4	1	UC
AFW-13	Urban Forestry Measures	1.4	4.3	34	–376	–11	UC
	SECTOR TOTAL AFTER ADJUSTING FOR OVERLAPS	7.8	29	212	222	1	
	REDUCTIONS FROM RECENT ACTIONS (none)	0	0	0	0	0	
	SECTOR TOTAL PLUS RECENT ACTIONS	7.8	29	212	222	1	

* UC = Unanimous Consent (all agree).

Agriculture, Forestry, and Waste Management Sector Mitigation Option Descriptions

The Agriculture, Forestry, and Waste Management Sectors include emissions and mitigation opportunities related to the use of biomass energy, protection and enhancement of forest and

agricultural carbon sinks, control of agricultural CH_4 emissions, production of renewable fuels, use of methods to increase soil carbon, achievement of afforestation on non-forested lands, and an increase in recycling.

AFW-1. Manure Digesters and Energy Utilization

The CH_4 emissions inherent from the anaerobic decomposition process of manure and other wastes may be captured and used as an energy source. By doing this, it is possible to both reduce CH_4 emissions and offset fossil-based energy. However, the cost of emission capture and energy production can be higher than the value of the energy collected, making this option cost prohibitive for producers operating in a tight-margin business. This option covers programs to increase the number of CH_4 capture and energy recovery projects using manure or other wastes (including food processor waste). The goal is to capture 20% of available CH_4 from confined animal operations by 2020 for use in energy projects. The mitigation option is designed to apply to hog farms and dairies in the state.

AFW-2. Biodiesel Production (Incentives for Feedstocks and Production Plants)

Use of biodiesel offsets the consumption of diesel fuel produced from oil (fossil diesel). Since biodiesel has a lower GHG content than fossil diesel, overall GHG emissions are reduced. By producing biodiesel in the state for consumption within the state, the highest benefits can be achieved, since the fuel is transported over shorter distances to the end user. This option covers incentives needed to increase biodiesel production to offset 12.5% of North Carolina's fossil diesel consumption by 2020.

Note: This option is linked with Transportation and Land Use Option 6 (TLU-6) on Biofuels. This option seeks to achieve incremental GHG benefits beyond the TLU option by promoting in-state production of biodiesel using feedstocks with greater GHG benefits than the likely business-as-usual national production methods. In addition, North Carolina consumption of biodiesel produced in-state will produce better GHG benefits than biodiesel obtained from a national market because of the lower embedded CO_2 associated with transportation of biodiesel or its feedstocks from distant sources.

AFW-3. Soil Carbon Management

Use of conservation tillage, no-till methods, cover cropping, and other soil management practices can increase the level of organic carbon in the soil, which sequesters CO_2. In addition, some practices lower fossil fuel consumption through less intensive equipment use. Other practices, such as the application of bio-char, can also increase the level of soil carbon and improve the soil.

Another element of this option is the promotion of certified organic production techniques. A number of studies have found that organic production of row crops results in GHG benefits, including higher levels of soil organic carbon relative to those from conventional production methods. This option is designed to increase the acreage using soil management and production

practices that lead to higher soil carbon content and other GHG benefits. Specific goals include applying soil management practices on 20% of acres that currently do not use these practices by 2010 and increasing that amount to 50% by 2020.

AFW-4a. Preservation of Working Lands – Agricultural Land

This mitigation option seeks to reduce the rate at which existing crop and pasture are converted to developed uses. The carbon sequestered in soils and aboveground biomass is much higher in croplands than in developed lands. Policies are needed to preserve working farms and forests (see AFW-4b) from unwise and unplanned development. This option should be seen as a companion measure to TLU-1a (Land Development Planning).

State and national programs have been established to protect farm communities from conversion to development. Funding state farmland preservation programs will help meet goals and act as a needed match to national programs. Programs that help farmers transition lands to beginning farmers are being investigated. The goal is to reduce the rate at which agricultural lands are converted to developed use by 50% by 2020 from current levels.

AFW-4b. Preservation of Working Lands – Forest Land

North Carolina has lost, on average, 61,390 acres of productive forest each year over the last 30 years to development and a lack of post-harvest regeneration. This amounts to a loss of about 10% of the state's forestland since 1974, or an annually compounded loss of about 0.36%. The goal of this option is to reduce the rate of conversion of forest lands to non-forest lands by 10% by 2010 and 25% by 2020. When converted to developed areas, these areas contain lower amounts of biomass and its associated carbon. These areas also sequester less CO_2 than forested areas. When landowners don't have the incentive to retain their ownership, they often not only sell for development, but they may also sell a forested tract as smaller parcels which may then be too small to allow forest management to be practical. On tracts too small and fragmented to be managed, the goals of AFW 9&10 cannot be achieved.

AFW-5. Agricultural Biomass Feedstocks for Electricity or Steam Production

This mitigation option seeks to offset fossil fuel use with agricultural biomass as feedstock for electricity, steam, or heat generation. Agricultural biomass includes, but is not limited to, poultry litter, livestock manure, and crop residues, as well as energy crops (e.g., switchgrass and hybrid poplar). Offsetting fossil fuel use reduces the GHG emissions associated with these fuels. The goals are to increase agricultural biomass usage to utilize 10% of available biomass by 2010, 25% of available biomass by 2020, and 50% of available biomass by 2030. Voluntary, incentive-based programs should be used to foster development of the industry and associated economic markets.

Note: This option links with AFW-1, which promotes the use of anaerobic digesters and energy utilization. It explores additional opportunities for agricultural biomass energy use. This option also has linkages to ES-1 (Renewable Energy Incentives), ES-2 (Environmental Portfolio

Standard), ES-10 (NC GreenPower Renewable Resources Program), and RCI-10 (Distributed Renewable and Clean Fossil Fuel Power Generation).

AFW-6. Policies to Promote Ethanol Production

Offset fossil fuel use (gasoline) with production and use of starch-based and cellulosic ethanol. Offsetting gasoline use with ethanol can reduce GHGs to the extent that the ethanol is produced with lower GHG content. Provide incentives for the production of ethanol from crops, forest sources, animal waste, and municipal solid waste. Several projects are being proposed that would result in the production of 150 million gallons of ethanol annually in North Carolina by 2008. Incentives could increase this amount to a volume equivalent to offsetting gasoline consumption in the state by 10% in 2015 and 25% by 2025. These goals are based on cellulosic ethanol being commercially viable by 2015.

Note: This option is linked to TLU-6, biofuels option, which focuses on mechanisms to increase biofuels consumption in North Carolina. The quantification of benefits and costs for each option takes into account the anticipated GHG reductions to be achieved by each.

AFW-8. Afforestation and/or Restoration of Non-Forested Lands

Afforestation, the planting of trees on lands that have not recently supported forests, has both carbon sequestration and other environmental benefits—storing more than one ton of carbon per acre each year (on-site, not including off-site storage and offsets in products). Afforestation delivers other important benefits such as improved wildlife habitat, reduced soil erosion and fertilizer runoff, and new recreational opportunities. Existing afforestation programs are underfunded for the task of this afforestation; typically, there is a long waiting list for landowner forestation projects. This option covers the provision of additional incentives to increase the rate of afforestation and restoration (e.g., increased stocking on poorly managed stands). The goals are to achieve afforestation projects on 40,000 acres of land by 2010 and a total of 540,000 acres by 2020.

AFW-9&10. Expanded Use of Forest Biomass and Better Forest Management

This mitigation option seeks to expand the production and use of wood products for solid wood products, fiber, and fuel. Such use offsets fossil fuel burning in the production of substitute materials (e.g., cement or steel for solid wood products and plastic for wood fiber). Wood can substituted for fossil fuels directly in the case of biomass for energy. However, these GHG benefits are not explicitly included in the analysis, which focuses on direct carbon sequestration in forests and in wood products. Having a market for relatively low-value biomass products enables forest management for higher value solid wood products. The increase in growth and yield of production from sustainably managed forest resources can be done through site preparation, competition control, thinning, fertilization, and improved genetics. The goal is to increase forest productivity by 100% on half of North Carolina timberlands by 2020.

AFW-11. Landfill Methane and Biogas Energy Programs

Provide incentives that will result in an increase in the recovery of landfill CH_4 for use as an energy source. Increasing recovery of landfill CH_4, reduces emissions of GHG and offsets the use of fossil fuels for commercial and industrial heat/steam generation or electricity production. Of approximately 130 open and closed landfills in the state, only about 15 sites are currently recovering landfill CH_4 for energy use. The aim of this mitigation option is to increase the number of uncontrolled municipal solid waste landfills recovering CH_4 as an energy source, such that 50% of the landfill gas being generated is controlled by 2020. This can be done through the development of additional LFGTE projects. For sites where LFGTE is not feasible, the aim is to implement flaring controls.

Note: This option has linkages to ES-1 (Renewable Energy Incentives), ES-2 (Environmental Portfolio Standard), ES-10 (NC GreenPower Renewable Resources Program), and RCI-10 (Distributed Renewable and Clean Fossil Fuel Power Generation).

AFW-12. Increased Recycling Infrastructure and Collection

Increase the quantity of materials recovered for recycling with specific attention given to materials with the greatest ability to reduce energy consumption during the manufacturing process and to materials that may be used as a fuel source (e.g., clean wood waste). Reducing the quantity of materials being put in landfills reduces the potential for future landfill CH_4 emissions, while recycling reduces emissions associated with the manufacturing of products from raw materials. The aim of this mitigation option is to increase per capita recovery in the state by 25% by 2020.

AFW-13. Urban Forestry Measures

Urban forest cover protection and management offers a potentially cost-effective mechanism to reduce energy use, to store/sequester carbon, and to mitigate land use change (conversion of forest and agricultural lands to residential sites). Strategic planting of trees to shade houses and AC units can yield energy savings of 15% to 50% on cooling costs. Planting shade trees can reduce summer heating costs, with only marginal increases in winter heating costs, particularly in mild climates. In addition, depending on local conditions, tree planting can reduce wind speed and further reduce energy costs. The net direct impacts of tree planting are estimated to be positive, taking these factors into account.

Specifically, this mitigation option aims to increase urban tree cover by planting three additional trees (i.e., three more than planned) on all new construction sites starting in 2008 and by planting three new trees on 25% of existing housing units in 2007 by 2020, with the aim of achieving a 25% reduction in annual heating and cooling costs.

Chapter 7
Cross-Cutting Issues

Overview of Cross-Cutting Issues

Some issues relating to climate policy cut across multiple or all sectors. The Climate Action Plan Advisory Group (CAPAG) addressed such issues explicitly in a separate technical work group as "cross-cutting" issues rather than assigning them to any individual sector. The Cross-Cutting Issues Technical Work Group (CC TWG) developed recommendations for each of six mitigation options (see Table 7-1) that were then reviewed, revised, and ultimately adopted by CAPAG as recommendations to North Carolina (NC) Department of Environment and Natural Resources (DENR). These issues include establishing an on-going function with the State of North Carolina to assess and forecast greenhouse gas (GHG) emissions, the reporting of GHG emissions by entities, the registering of any GHG reductions achieved by entities for possible future credit and/or recognition, a variety of public education and outreach initiatives regarding climate change, and recommendations for a voluntary goal to reduce statewide GHG emissions. In addition, the CAPAG adopted a recommendation to create a state-sanctioned Blue Ribbon Commission on Adaptation to Climate Change to develop a comprehensive state Climate Change Adaptation Plan identifying opportunities to address adaptation issues and risks.

Table 7-1
CAPAG Recommended Mitigation Options and Results for Cross-Cutting Issues

	Mitigation Option Name	GHG Reductions ($MMtCO_2e$)			Net Present Value 2007–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of Support*
		2012	2020	Total 2007-2020			
	Cross-Cutting Issues						
CC-1	GHG Inventories and Forecasts	*Non quantified*					UC
CC-2	State Greenhouse Gas Reporting	*Non quantified*					UC
CC-3	State Greenhouse Gas Registry	*Non quantified*					UC
CC-4	State Climate Public Education and Outreach	*Non quantified*					UC
CC-5	State Climate Change Adaptation Strategy	*Non quantified*					UC
CC-6	Options for Goals or Targets (for CAPAG in support of LCGCC)	*Non quantified*					UC

* UC = Unanimous Consent (all agree).

Key Challenges and Opportunities

Establishing a GHG inventory and forecasting function within state government will assist in the tracking, managing, and ultimately reducing GHG emissions. Establishing this function at the Division of Air Quality (DAQ) offers significant opportunities for the state to systematically and

efficiently integrate this function with the DAQ's expertise and its on-going program to develop inventories and forecasts for the criteria air pollutants. It will also enable multi-pollutant assessments of air emissions programs within the state since criteria air pollutant and GHG emissions will be based on the same emission source activity data.

The GHG reporting and registry programs present special challenges and opportunities. Any regional or national effort involves reconciling the interests and perspectives of different states. The states are at much different stages of the learning curve with respect to these and other climate actions. After the CAPAG completed its recommendations on these mitigation options, North Carolina joined *The Climate Registry* as a step toward developing a nationally uniform GHG reporting and registry capability for North Carolina sources.[1] Being a charter state in this effort creates a unique opportunity for North Carolina to help ensure that North Carolina's needs and priorities are addressed in the course of *The Climate Registry*'s development. To the extent that North Carolina's needs may not be fully met by *The Climate Registry*, the state should consider developing supplemental or ancillary registry capacity or opportunity.

Public education and outreach programs can be difficult to develop and measure, but successful climate action will ultimately hinge on the public's awareness of climate risks and solutions. Public education and outreach efforts should integrate with and build upon existing outreach efforts involving climate change and related issues in the state. Ultimately, public education and outreach will be the foundation for the long-term success of all the mitigation actions proposed by the CAPAG as well as those which may evolve in the future. Key challenges may be associated with coordinating existing efforts by state agencies and securing long-term funding to support these programs. However, these challenges also offer opportunities for improving the effectiveness of education and outreach efforts over the long term.

The CAPAG recommends that the state set a voluntary GHG reduction goal but that the adoption of such a goal should first be considered by the NC Legislative Commission on Global Climate Change (LCGCC). If recommended by the LCGCC, such a goal could be established by the General Assembly or by an executive order of the Governor. By setting and adhering to a GHG reduction goal, North Carolina will join many other states across the country that are demonstrating leadership in reducing their own GHG emissions. It will also provide an incentive for North Carolina citizens, businesses, and state and local governments to seek out economic opportunities to reduce GHG emissions and to position North Carolina as a supplier of carbon credits to developing carbon markets while simultaneously reducing energy costs.

Due to the existing buildup in the atmosphere of GHGs that has already occurred, North Carolina will experience some effects of climate change for years to come, even if immediate action is taken to reduce future GHG emissions. Recognizing this concern, the CAPAG agreed unanimously that it is essential for the state to initiate efforts to identify potential short-term,

[1] The Climate Registry (http://www.theclimateregistry.org/) is a collaboration between states, provinces and tribes aimed at developing and managing a common GHG emissions reporting system with high integrity that is capable of supporting various GHG emission reporting and reduction policies for its member states and tribes and reporting entities. It will provide an accurate, complete, consistent, transparent and verified set of GHG emissions data from reporting entities, supported by a robust accounting and verification infrastructure. As of July 2007, 39 US states, several Tribal Authorities, two Canadian Provinces, and one Mexico state have joined *The Climate Registry*.

mid-term, and long-term impacts of climate change scenarios likely to affect the state and develop a framework for prioritizing and responding to the potential impacts identified. Thus, the CAPAG recommends that the state empanel a Blue Ribbon Commission on Adaptation to Climate Change to develop a state Climate Change Adaptation Plan within one year of establishment of the Commission. The Commission should involve and coordinate with all appropriate state and local agencies, organizations, and institutions (e.g., universities) to ensure that all potential impacts are identified in the plan. This recommendation offers challenges in that legislative approval for funding will be required to support the Commission and development of the plan. However, developing a sound, coordinated planning effort to address North Carolina's vulnerabilities to climate change is likely pay for itself many times over, will help to establish priorities, and assist in identifying opportunities for mitigating health and economic impacts associated with climate change in the state.

Overview of Mitigation Option Recommendations

Cross-cutting issues include options that apply across the board to all sectors and activities. Cross-cutting recommendations typically encourage, enable, or otherwise support emissions mitigation activities and/or other climate actions. The CAPAG recommends six such options be adopted and implemented by the State. All six are enabling options that are not quantified in terms of tons of reductions or costs/cost savings. Detailed descriptions of the individual Cross-Cutting Issues mitigation options as presented to and approved by the CAPAG can be found in Appendix I. Annex A to Appendix I offers additional reference materials that the CAPAG used in developing its recommendations for the inventories and forecast, reporting, registry, education and outreach, and adaptation mitigation options.

Cross-Cutting Issues
Mitigation Option Descriptions

CC-1 GHG Inventories and Forecasts

GHG emissions inventories and forecasts are essential to understanding the magnitude of all emission sources and sinks (both anthropogenic and natural), the relative contribution of various types of emission sources and sinks to total emissions, and the factors that affect trends over time. CCS is providing a baseline inventory as a part of this project. It should be a platform for further updating and improvement. The initial use for inventories and forecasts will be to inform state leaders and the public on statewide trends, opportunities for mitigating emissions or enhancing sinks, and verifying GHG reductions associated with implementation of North Carolina's Climate Action Plan. However, it is expected that other uses of the data will be identified as the program evolves.

The CAPAG recommends that the responsibility for preparing GHG inventories and sinks should reside with the DAQ, which has the expertise needed to systematically compile information on GHG sources and sinks using established methods and data sources. Other state agencies as well as private facilities (sources) will need to provide data to DAQ on a periodic basis. This program

should be integrated with existing DAQ inventory and forecast functions as seamlessly as possible as committed to by DAQ in the September 2005 Report under the Clean Smokestacks Act. This inventory and forecast function should be implemented as soon as possible to establish an on-going effort that will be improved over time based on improvements to the accuracy and completeness of data needed to support this effort.

The CAPAG recommends that the state develop a periodic, consistent, and complete inventory of all emission sources and sinks (both anthropogenic and natural) on a continuing basis with forecasts to reasonable and realistic future years (5 and 10 years), to and including 2020 (and eventually beyond), as allowed by funding. The process for these and other sources should repeat as often as necessary to track significant reductions or increases, beginning with every year for major point sources and every third year for other sources to be in agreement with routine EPA air emissions reporting requirements and regulations for other regulated air pollutants. The inventory should include all natural and man-made emissions generated within the boundaries of the state (i.e., production-based inventory approach) as well as emissions associated with energy imported and consumed in the state (i.e., consumption-based inventory approach). The state should provide a projection of the emissions from the same source categories and on the same basis into the future for a realistic forecast of what the emissions will be in future years reflecting expected growth and application of scheduled and expected mitigation options. The state should also provide a basis for documenting emission reductions and credits "by difference" from year to year.

CC-2 State Greenhouse Gas Reporting

GHG reporting reflects the measurement and reporting of GHG emissions at a statewide, sector, or sub-sector level to support tracking and management of emissions. GHG reporting can help sources identify emission reduction opportunities and reduce risks associated with possible future GHG mandates by moving "up the learning curve." Tracking and reporting of GHG emissions would also help in the construction of periodic state GHG inventories. GHG reporting is typically a precursor for sources to participate in GHG reduction programs, opportunities for recognition, a GHG emission reduction registry, and to secure "baseline protection." Further, collaboration with other states in the development of a GHG reporting program could enable North Carolina to influence the development of GHG reporting practices throughout the region and nation and build consistency and reciprocity with other state or regional GHG reporting programs.

Accordingly, the CAPAG recommends that North Carolina develop and implement a voluntary GHG reporting program as soon as possible. Reporting should occur annually on a calendar-year basis for all six traditional GHGs and, to the extent possible, for black carbon. In order to encourage GHG mitigation activities from all quarters, all entities that can verify ownership of GHG emissions should be encouraged to participate in a reporting program. Every effort should be made to maximize consistency with federal, regional, and other states' GHG reporting programs and quantification protocols in order to maximize consistency and reciprocity with federal, regional, and other states' GHG reporting programs. The reporting of GHGs would help position sources for participating in an emissions trading program, should one develop in the future, leading to cost savings.

For entities participating in a reporting program, reporting of direct emissions should be required; reporting of emissions associated with purchased power and heat should be phased in; and reporting of other indirect emissions should be allowed. Reporting of GHG emissions should be on an organization-wide basis within North Carolina, but with greatest possible detail by facility in order to facilitate baseline protection. Reporting of emissions from GHG reduction projects should qualify for reporting when they are identified as such, and adhere to equally rigorous quantification standards. GHG emissions reports should be verified through self-certification and NC DENR spot-checks. To qualify for future registry purposes, reports should undergo third-party verification. The reporting program should provide for appropriate public transparency of reported emissions. GHG reporting may be required by DAQ for some categories of sources through normal state rulemaking procedures.

It should be noted that many sources in North Carolina report criteria pollutant emissions to DAQ in order to comply with various federal and state regulatory programs. Most electricity generating units are also required to report CO_2 emissions to the Environmental Protection Agency's Acid Rain Program. Some sources may report GHG emissions on a voluntary basis to federal, state, or privately-run programs. In addition, the DAQ will be collecting GHG emissions from stationary sources subject to a North Carolina state Title V air permit beginning in calendar year 2008 to fulfill a commitment under the Clean Smokestacks Act. The CAPAG acknowledges these emission reporting programs and DAQ's efforts to systematically integrate the reporting of GHG emissions by entities to the state in order to minimize costs to both the reporting entities and the state of North Carolina.

CC-3 State Greenhouse Gas Registry

A GHG registry enables uniform measurement and recording of GHG emissions reductions in a central repository. Typically, a registry also includes transaction ledger capability in order to support tracking, management, and ownership of emission reductions. Registries can help encourage sources to undertake GHG reduction efforts, enable potential recognition for such actions, provide baseline protection, and support the crediting of GHG mitigation actions. A registry can also provide a mechanism for regional, multi-state, and cross-border cooperation. Subject to appropriately rigorous quantification standards, participation in a GHG registry should not be constrained to particular sectors, sources, or approaches in order to encourage GHG mitigation activities of all types from all quarters. In particular, a GHG registry should be able to incorporate activities associated with all of the options that the CAPAG approves, whether reflective of reductions in emissions of GHGs or increases in biological or geological sequestration of carbon.

Building on the GHG reporting program recommended in CC-2, the CAPAG recommends that North Carolina actively engage with other states in developing a regional or national GHG registry that will comprehensively meet the state's needs as soon as possible. If developing regional or national multi-state registries do not initially include all of the state's preferred criteria, North Carolina should still join and participate to the greatest extent possible, and work to develop whatever additional registry capacity is necessary to meet the remaining needs of North Carolina sources (e.g., registration of carbon sequestered due to reforestation). Together, these approaches should cover all mitigation options the CAPAG recommends, provide adequate

quality verification, and allow project-level reporting. Participation by North Carolina sources should be voluntary, include all entities that can verify ownership of GHG emission reductions, and costs should be borne primarily by participants. Entities should be provided the opportunity to participate in a registry as soon as possible after a GHG reporting program is operating.

The CAPAG recommends that the state ensure that any registry in which it decides to participate includes (1) voluntary participation by as broad an array of sectors, sources, facilities, and approaches as possible; (2) provide for participation by entities at least at the statewide level and as broadly (i.e., regionally or nationally) as possible; (3) allow sources to start as far back chronologically as good data exists, as affirmed by third-party verification, and allowing registration of project-based reductions or "offsets" that are equally rigorously quantified; (4) incorporate adequate safeguards to ensure that reductions aren't double-counted by multiple registry participants, and providing appropriate transparency; (5) strive for maximum consistency with other state, regional, and/or national efforts and the greatest flexibility possible as GHG mitigation approaches evolve; and (6) provide guidance to assist participants.

In addition, the registry should allow the state and its political subdivisions to be valid participants for registering reductions associated with their programs, direct activities, or efforts, including the registration of emission reductions associated with the stationary and mobile sources they own, lease, or operate. The state and its political subdivisions should also be allowed to participate in emission trading if and when such a program is developed and authorized. Revenues associated with the sale of any emission reduction credits generated by the state or its political subdivisions could be used to support the GHG emission inventory, forecasting, reporting, and registry functions within state government.

CC-4 State Climate Public Education and Outreach

Public education and outreach can support GHG emissions reduction efforts at the macro- or micro-scale in relation to emissions reduction programs, policies, or goals. Public education and outreach is vital to fostering a broad awareness of climate change issues and effects (including co-benefits, such as clean air and public health) among the state's citizens. Such awareness is necessary to engage citizens in actions to reduce GHG emissions. Public education and outreach efforts should integrate with and build upon existing outreach efforts involving climate change and related issues in the state. Ultimately, public education and outreach will be the foundation for the long-term success of all the mitigation actions proposed by the CAPAG as well as those which may evolve in the future.

The CAPAG recommends that North Carolina lead by example in its own education and outreach activities by establishing a pro-active public education and outreach capability and using it to target education and outreach activities to five specific audiences: (a) policymakers and managers (e.g., legislators, regulators, executive branch, agencies, and employees); (b) educators and students; (c) community leaders and community-based organizations (e.g., institutions, municipalities, service clubs, social and affinity groups, and non-governmental organizations); (d) the general public; and (e) industrial and economic sectors (such as professional training, licensing, and certification programs). A statewide public education and outreach effort should probably be overseen largely by NC DENR, but would necessarily involve

many other key parties. Public education and outreach efforts should commence as rapidly as possible.

CC-5 State Climate Change Adaptation Strategy

Due to the existing buildup in the atmosphere of GHGs that has already occurred, North Carolina will experience some effects of climate change for years to come, even if immediate action is taken to reduce future GHG emissions. Thus, it is essential that the state develop a plan to manage the projected impacts of ongoing climate change while worldwide mitigation efforts to lower atmospheric concentrations are underway.

While taking action to reduce GHG emissions in North Carolina, the state should develop, adopt, and implement a state Climate Change Adaptation Plan that includes identification of (a) potential short-term, mid-term, and long-term impacts of climate change scenarios likely to affect the state, and (b) implementation mechanisms for addressing these impacts. The state should empanel a state-sanctioned Blue Ribbon Commission on Adaptation to Climate Change as soon as possible to develop a state Climate Change Adaptation Plan within one year of establishment of the Commission. The Commission should involve and coordinate with all appropriate state and local agencies, organizations, and institutions (e.g., universities) to ensure that all potential impacts are identified in the plan. The Commission should also enlist the expertise of all appropriate state and local agencies, organizations, and institutions in developing and implementing measures for mitigating these impacts.

At a minimum, the Commission should address in the plan the adaptation issues that the CAPAG has identified for this option in Appendix I. Benefit-cost analyses should be used to compare the potential costs of a "status quo" approach as opposed to implementing the recommendations proposed in the Climate Change Adaptation Plan. Recommendations in the adaptation plan should be prioritized based on the certainty and severity of adverse impacts to citizens, ecosystems, and local economies. Development of the plan should (a) involve all affected agencies and entities at all levels of government; (b) involve all affected sectors and interests; and (c) provide for periodic review and update concerning adaptation risks, responses, and opportunities in the state. Parallel public education and outreach efforts regarding adaptation should commence immediately. "Early-adoption" opportunities should be addressed as rapidly as possible (even before the Commission is established, if possible), and pro-active adaptation initiatives should commence within the next 2–3 years.

The CAPAG also recommends that the State Legislature provide funding to support development and on-going revision to the state Climate Change Adaptation Plan including, but not limited to, funds to support the benefit-cost analysis needed to guide and inform the development and implementation of the Plan and to cover expenses incurred by the Commission and Commission members.

CC-6 Options for Goals or Targets (for CAPAG in support of LCGCC)

It is widely anticipated that eventually the federal government may cap GHG emissions associated with global warming. A number of states are ahead of the federal government in establishing GHG caps. For example, the Northeastern States (including New York) have instituted a regional cap and trade program to reduce power-sector GHG emissions. California has recently signed into law an economy-wide cap.

North Carolina has successfully severed the link between increasing energy consumption and emissions of soot and smog-forming pollution; even as energy consumption increases, sulfur dioxide and nitrogen oxide pollution are being significantly decreased.

North Carolina should establish voluntary goals to limit GHG emissions to prepare the state's economy for the likely caps at the national level, and begin to sever the link between increasing energy demand and GHG emissions. Even modest reductions in GHG emissions will help to align North Carolina's environmental and economic interests, and assist the state in addressing its contribution to global warming. The goal would not be mandatory, but simply sets a direction in GHG emissions, just like the NC million acre conservation goal.

The CAPAG recommends that the State of North Carolina set an overall voluntary goal to bring statewide emissions back to a baseline, such as year 2000. The goal should be set over a long-time horizon of 10–15 years to meet the baseline. It should be expressed as an interim goal on the longer path toward ultimate climate stabilization. There would be no mandates to any specific party. However, all sectors of the state's economy would have the opportunity to contribute toward meeting the state's goal. The adoption of such a goal should first be considered by the NC Legislative Commission on Global Climate Change (LCGCC). If recommended by the LCGCC, such a goal could be established by the General Assembly or by an executive order of the Governor.

The CAPAG identified the following benefits associated with setting a goal to reduce statewide emission:

- **Addressing Potential Global Warming Impacts**—The direct economic toll of global warming on North Carolina may be enormous and would likely include increasing: crop loss due to drought, episodic water shortages, coastal flooding and erosion, and building cooling costs. A state goal will draw attention to regional warming trends and associated effects and help business and government prepare for the future.
- **Economic Development**—As the state plans its economic development activities, a state carbon reduction goal can help promote expansion and recruitment of renewable energy technologies that are less GHG intensive. Additionally, these activities will seek to generate jobs in North Carolina to replace the non-native coal and gas sources that currently dominate North Carolina's energy supply.
- **State Leadership**—By establishing a state goal, North Carolina will join the numerous states across the country that are already rising to the challenge of addressing GHG emissions associated with global warming.

- **Business Responsibility**—A state goal will be to provide the motivation and opportunity for companies to examine their options for cost-effective reductions in their GHG emissions. Many companies in North Carolina are already considering the need to reduce carbon dioxide in their long-term planning. A reduction goal will foster the broader business community to consider their ability to also reduce GHG emissions.
- **Preparing for the Emerging Carbon Marketplace**—North Carolina business can potentially sell tens or even hundreds of millions of dollars worth of carbon equivalence credits into the carbon marketplace that national climate legislation will eventually generate. A state goal would help companies that could potentially be suppliers of carbon credits in the coming national marketplace prepare to take advantage of these economic opportunities as soon as they arise.

Appendix A
Description of CAPAG Process

Memo

To: North Carolina Climate Action Plan Advisory Group
From: The Center For Climate Strategies
Date: February 16, 2006

Background

DENR/DAQ Activities

In September 2005, under the Clean Smokestacks Act of 2002 (CSA), the North Carolina Department of Environment and Natural Resources (DENR) and Division of Air Quality (DAQ) delivered a required report to the Environmental Management Commission (EMC) and the Environmental Review Commission (ERC) (of the General Assembly) pursuant to legislative requirements in the CSA that included:

1) Identification and evaluation of carbon dioxide reduction strategies for coal fired utilities and other major stationary sources, and
2) Alternative potential GHG reduction strategies (a limited set of measures beyond carbon dioxide reduction strategies for coal fired utilities and other major stationary sources (identified in step #1), including measures related to other GHG's and sectors)

The final DAQ CSA report to the ERC and EMC included a series of recommendations for state actions on GHG emissions in the stationary source sector, as well as recommended alternative reduction strategies for other sectors. Some actions recommended in the CSA report can be implemented by the state in the near term, while others require further development. Other potential mitigation actions that are likely applicable to North Carolina are not identified in this report. The 2005 DAQ CSA report also includes a comprehensive inventory and forecast of North Carolina GHG emissions from 1990-2020. This assessment was developed using default methodologies from the US EPA State Greenhouse Gas Inventory Tool (SGIT) with substantial augmentation and modification based on the Center for Climate Strategies' (CCS)experience and conferral with DAQ and the SEO. These support tasks were assisted by the CCS.

The CSA report contains a recommendation to continue state GHG mitigation planning through formation of a DAQ stakeholder process to further identify and develop policy actions (recommendation #1) in the form of a Climate Action Plan.

Legislative Activities

During 2005, the General Assembly continued consideration of further legislation on climate change, and ultimately established the North Carolina Legislative Commission on Global Climate Change (the Commission). Section 5 of this Law identifies a number of fact-finding requirements that relate to state-level GHG planning, including determination of the need for a GHG reduction goal and if so, what level of reduction that might be.

Information needs of the Commission may appear to overlap work conducted already under the CSA. However, the goals and process are actually complementary and expected to interface closely with future GHG planning and assessments by DENR/DAQ that are the subject of this memo. The GHG planning process (hereafter referred to as the North Carolina Climate Action Plan Advisory Group (CAPAG), supported by this continuing DAQ/DENR effort is expected to address a number of information gathering needs of the Commission as they relate to climate mitigation policy and work already done pertinent to North Carolina and other states.

Tasks of the CAPAG and Commission Processes

Requested information from the CAPAG and Commission processes, when combined, includes:

(1) GHG emissions inventories and forecasts
(2) Inventories and assessments of impacts of existing and future policy actions
(3) Identification of alternative potential GHG reduction strategies
(4) Assessment of potential benefits and costs
(5) Distribution of costs and benefits
(6) Identification of economic opportunities and impacts
(7) GHG reporting measures
(8) Statewide goals determination (Legislative Commission)

The CAPAG process will be conducted concurrently and in regular communication with the Commission, potentially including regularly being on its meeting agenda. While the two processes are separate, they share some overlapping participants and will communicate through regular briefings (to be scheduled). Findings from the CAPAG process will thus be available for consideration by the Commission at its meetings, and feedback will available for consideration by members of the CAPAG planning process.

Description of the CAPAG Process

Purpose And Goals

The purpose of the CAPAG will be to develop public recommendations to DENR/DAQ for a state-level climate action plan, focusing in particular on economic opportunities. This process also will provide information to the Commission to assist in providing information needs under Section 5 of the Act. The goal of the CAPAG will be to seek consensus on a comprehensive series of individual, potential actions to reduce GHG's in North Carolina. The level of support for specific actions and the full range of CAPAG views will be documented. Statewide targets and or goals, to the extent that they are developed, will be based on results of the Commission's deliberation on this issue.

CCS will provide CAPAG recommendations to DENR/DAQ in a final report to cover the following:

1) Executive Summary
2) Background, Purpose And Goals
    a. Description Of The CAPAG Process
    b. History And Status Of State Actions, Including a Description of State Efforts Underway
    c. Inventory And Forecast Of State Emissions
3) Policy Recommendations
    a. Agriculture and Forestry (also including carbon storage)
    b. Energy Supply (including electricity generation)
    c. Residential, Commercial and Industry (also including industrial process)
    d. Transportation and Land Use (also including biofuels)
    e. Cross-Cutting Issues (including reporting, registries and education)

Process Design

Activities of the CAPAG process will be:

- Stepwise: The process will follow a set master schedule of discussion and decision items and iterate to consensus. As such it will require continuity among participants. CAPAG and technical work group (TWG) participants are expected to regularly attend meetings. Alternates should attend only as needed due to schedule conflicts.
- Fact based: Technical analysis and policy design will be achieved through preliminary and joint fact-finding and, ultimately, joint policy development by CAPAG members and TWGs assisted by a facilitation and technical consulting team (CCS).
- Consensus driven: The state will seek but not mandate consensus through this process, and final decisions by the CAPAG will be made through decision criteria and voting procedures that allow a full expression of viewpoints. Four voting

categories will be used, including: *unanimous consent* (all agree), *super majority* (90 percent agree), *majority* (51 percent agree) and *minority view* (less than 50 percent agree).

- Self-determined: The process starts with no pre-commitments to particular policies. Priorities for analysis and final recommendations will be self-determined through informed judgments by the CAPAG and TWGs. CAPAG members will be free to review and suggest revisions to DAQ's September 1, 2005 recommendations under the CSA, including addition of new options to the list of potential options and revisions to the design and implementation of specific options in the CSA report.
- Informal and nonbinding: The process will be advisory and nonbinding to the state to provide public input for potential future policy decisions. It is structured as an informal consensus building effort to provide a full opportunity for CAPAG members to make voluntary decisions on recommended policies.
- Transparent: The processes will be transparent. Policy options will include clear design parameters such as levels, timing, coverage and implementation mechanism. Technical analyses will include clear disclosure of data, methods, sources and assumptions. All proceedings will be posted to the project website by CCS after review for accuracy by DAQ.
- Inclusive: The process will include CAPAG and TWG members, and opportunities for public input.
- Flexible: Throughout the process the facilitation team will check with participants and the state on progress and any potential need for revision. Proposed changes will be shared openly with the group.

Key steps and parameters of the process include the following:

- The CAPAG and TWGs will explore solutions in all sectors, covering: energy supply; commercial, industrial and residential energy use and process related emissions (energy efficiency and conservation); transportation and land use; agriculture and forestry; waste management, and cross-cutting issues.
- The process will start with examination of a compendium of related policy actions undertaken in North Carolina as well as other states and regions, including CSA recommendations, with addition of new options, adaptation to North Carolina circumstances, and prioritization based on CAPAG preferences.
- Mitigation of all GHG's will be examined, including carbon dioxide, methane, nitrous oxide, synthetic gases and, potentially, black carbon. Units will be expressed in metric tons (MT) carbon dioxide equivalents (CO_2e).
- Historical emissions inventories and reference case projections will be developed for years 1990-2020.
- Recommendations for action will include the present to year 2020, with estimated benefit and cost impacts being reported for 2010 and 2020.
- Recommendations may include state-level and multi-state actions (regional and national), as well as voluntary and mandatory approaches.

- Recommendations will include both quantified and non-quantified actions, with emphasis on numerical analysis of GHG reduction potential and cost effectiveness under available funding and project timetables. Additional issues will be evaluated on a case-by-case basis pending CAPAG input.
- CAPAG discussions will explore alternative policy designs and additional analysis as needed to reach final consensus with assistance from the facilitation team and TWGs.
- The final report will document CAPAG recommendations and views on each policy option, including alternative views as needed.

At the conclusion of the processes, CAPAG recommendations will be presented in a CCS report to DENR/DAQ.

State Leadership And Management

DENR Secretary Bill Ross will convene the CAPAG. DENR/DAQ will organize and coordinate the process with support and assistance by CCS. CCS will report to DENR/DAQ on behalf of CAPAG members and provide facilitation and technical analysis to the CAPAG and TWGs. CCS will provide DENR/DAQ documents for review prior to website posting for CAPAG meetings, and will coordinate with staff on technical assistance, logistical support and other issues as needed.

State agency representatives will serve as voting members and/or nonvoting technical advisors of the CAPAG and TWGs. DAQ will oversee the CAPAG process in coordination with CCS, assist CCS with planning and implementation of the process and provide input on policies and issues identified by CAPAG members, the public and TWGs as needed. The state will provide logistical support for meetings, facilities, public notice and posting of materials as needed, with assistance and coordination by CCS.

CAPAG Members

A group of public participants representing a variety of North Carolina organizations and companies selected by the DENR/DAQ and invited to be members of the CAPAG, include broad economic sectors in the state. They will be tasked with making formal decisions and developing recommendations on policy actions with assistance by the CCS team.

TWG Members

TWG members will be comprised primarily of CAPAG members assigned to specific sectors of interest. These TWGs will be augmented with additional technical experts and interested parties as needed. They will be selected by the state with assistance from CCS. TWGs will be organized at the first CAPAG meeting. The TWGs will advise the CAPAG and complete tasks designated by the CAPAG as priorities. TWGs will cover all sectors that include: 1) energy supply (including electricity and natural gas), 2) commercial, industrial and residential (including energy efficiency and conservation), 3) transportation

and land use, 4) agriculture and forestry, and 5) cross-cutting issues (such as reporting, registries, and education).

TWGs will be tasked with providing guidance to CAPAG members on priorities for analysis, technical analysis and design of options, alternative approaches, and final recommendations.

The Public

The meetings of the CAPAG will be conducted in accordance with open meetings and public information requirements and policies in effect for the state. Meeting notices, advance materials and minutes of previous proceedings will be made available to the public through the project Web site and other means. Public input may be provided as a routine designated part of CAPAG meetings.

Participant Guidelines

CAPAG and TWG members are expected to follow certain codes of conduct during the process, including:

- Attendance is strongly requested at all meetings to provide continuity to the stepwise process. Alternates may be named when absolutely necessary.
- Active involvement in proposals and evaluations is needed from each member to fully support the process of joint policy development.
- Good faith participation and full support of the process are required.
- In exchanging information and views, CAPAG members should make fact-based offers and statements, and refrain from personal criticisms.
- CAPAG and TWG members should not represent the state or CAPAG in contacts with the media.

Facilitation

CCS will serve as facilitator of the CAPAG and TWGs. Facilitation responsibilities include:

- Reporting to DENR/DAQ on behalf of CAPAG members and providing coordination and management support for the CAPAG process
- Direction and coordination of technical consultants and TWG leaders, including meetings and calls
- Planning and supervision of CAPAG meetings, calls, reports and documents
- Facilitation and management of CAPAG meetings
- Coordination of CCS activities with DENR/DAQ and other state agency technical and support staff as needed
- Conducting public meetings as needed

To support facilitation and project management, CCS will provide a project website (www.ncclimatechange.us) for use by participants. DAQ will approve the design of the site and documents for posting by CCS. CCS will be responsible for posting documents and managing the site following DAQ approval. At the conclusion of the process, public materials from the website will be transferred to DENR/DAQ for ongoing management and use by the state.

As a part of its role as evaluative facilitator, CCS voluntarily abides by the model standards of conduct by the American Arbitration Association, American Bar Association and the Association for Conflict Resolution as applicable to the advisory process as an informal, consensus building initiative.

Technical Team

The CCS technical team will serve as a neutral and expert group to inform and support the development of technical and policy consensus. Technical staff will perform analyses and provide support based on CAPAG and TWG decisions. The team will be composed of the process facilitator and five TWG leaders. Other consultants will be deployed as needed for specialized analysis or additional capacity. State agency staff and TWG members will be asked to assist CCS in formulation and analysis of options.

Fact Finding

Preliminary fact finding prior to the first CAPAG meeting will include:

- Development of a draft emissions inventory and reference case forecast (completed under the DENR/DAQ CSA report)
- Identification of a compendium of conceivable options for CAPAG augmentation and consideration (completed under the 2005 DAQ CSA report), including potential actions identified under the 2005 DAQ CSA report.

Joint fact finding after the first CAPAG meeting will include:

- Finalization of GHG emissions inventories and reference case forecasts for sectors
- Identification of a "long list" compendium of conceivable policy options in North Carolina
- Identification of actions already underway in North Carolina
- Ranking and identification of initial priorities for analysis
- Development of initial policy design parameters and evaluation methods (including technical agreement on appropriate data sources, methods and assumptions for analysis of policy options), and joint model development as needed
- Identification and analysis of alternative policy designs, including implementation mechanisms

- Final benefit and cost analysis, and related analysis of secondary impacts, and ancillary and feasibility issues as needed
- Identification of cross-cutting issues and integrated policy analyses as needed
- Statewide and sector based economic modeling, as necessary

Timing and Milestones

The first meeting of the CAPAG is scheduled for launch February 16, 2006, with up to five additional CAPAG meetings to be held through late winter of 2007. We plan for one or two TWG conference calls to be held between CAPAG meetings as needed, along with interim briefings and reports to DENR, EMC, ERC and the Legislative Commission, according to a schedule to be determined by the DENR/DAQ. A final report with CAPAG recommendations will be provided to DENR/DAQ by June 30, 2007, and earlier if possible, following a period of review by the CAPAG and the public.

Draft Project Calendar

February 2006	1st CAPAG meeting
April 2006	2nd CAPAG meeting
June 2006	3rd CAPAG meeting
August 2006	4th CAPAG meeting
October 2006	5th CAPAG meeting
February 2007	6th CAPAG meeting
May, 2007	Report review
June 2007	Final DENR/DAQ Report Due
Between CAPAG Meetings	TWG conference calls, briefings and reports as needed.

Draft CAPAG And Technical Work Group Meeting Agendas

MEETING ONE

- Introductions
- Purpose and goals
- Review of the CAPAG process and its relation to CSA and the Commission
- Review of CSA recommendations by DENR
- Identification and recognition of existing actions being taken in North Carolina and other states
- Emissions inventory & forecasts
- Key policy opportunities & issues
- Formation of TWGs, next meeting agenda

Interim TWG calls (to be scheduled by CCS) will cover: 1) suggested revisions to the draft inventory and reference case projections, 2) review and suggested modifications to the "long list" of policy options, 3) early ranking of options and suggested initial priorities for analysis, including CSA recommended options

MEETING TWO

- Recommended updates to inventories and baseline forecasts
- Discussion of additional "long list" of conceivable additional North Carolina policy actions
- Review and discussion of initial priorities for TWG analysis
- Review of TWG plans, including quantification
- Identification of cross-cutting issues

Interim TWG calls to cover: 1) suggested final revisions to the emissions inventory and reference case projections, 2) suggested modifications to the list of initial priorities for analysis for CAPAG review, 3) suggested policy designs for specific policy actions for CAPAG review, 4) next steps on design and analysis of initial policy options

MEETING THREE

- Final agreement on inventories and baseline forecasts
- Approval of TWG lists of policy priorities for analysis
- Discussion of policy design and implementation mechanisms for policy options, process for developing straw proposals
- Briefing on cross cutting issues and policy options

Interim TWG calls to cover: 1) development of straw proposals for design parameters for individual options, 2) identification of potential implementation mechanisms for options, 3) next steps for analysis of options, 4) identification of cross-cutting policy needs

MEETING FOUR

- Review of policy options list, straw proposals for policy design, and early results of analysis
- Guidance to TWGs on additions, deletions and modifications of options
- Identification of alternative policy designs and implementation mechanisms for TWGs, as needed
- Review and revision of cross cutting policy options

Interim TWG calls to cover: 1) revisions to draft final policy priorities and design parameters, including implementation mechanisms, 2) next steps for draft analysis of options and design alternatives, and 3) next steps on formulation of cross cutting policy options and mechanisms

MEETING FIVE

- Review of options list, with results of analysis and cumulative emissions reductions potential
- Identification of consensus and non consensus options
- Identification of barriers and alternatives for non consensus options, with guidance for additional work on options to TWGs

- Review of final report progress and plans

Interim TWG calls to cover: 1) final revisions to design parameters, including implementation mechanisms, 2) final analysis of options, alternatives, and 3) final steps on formulation of cross cutting policy options and mechanisms

MEETING SIX

- Progress report on non-consensus policy options list and cumulative emissions reductions potential
- Identification of consensus and non consensus options from remaining list
- Identification of barriers and alternatives for non consensus options, proposals for resolution by the CAPAG
- Discussion and final resolution of barriers and determination of consensus for remaining options
- Summary of the process, review of next steps for review and transmittal of the final report

CCS team completes CAPAG updates to policy options and draft final report language.

PUBLIC REVIEW OF THE DENR/DAQ REPORT

FINAL DENR/DAQ REPORT

Appendix B
Members of Technical Work Groups

*Also a member of CAPAG
( ) Names in parentheses also served as alternates

RESIDENTIAL, COMMERCIAL, INDUSTRIAL, AND WASTE MANAGEMENT SECTORS

John Calcagni, NC DENR Division of Pollution Prevention and Sustainability
Jerry Coker, Weyerhaeuser*
Kristen Coracini, Environmental Defense
Steve Halsted, North Carolina Council of Churches*
Joe Harwood, Duke Energy
Len Hoey, North Carolina State Energy Office
Gary Hunt, NCDENR Division of Pollution Prevention and Sustainability*
Edward Kreul, International Paper
Ward Lenz, Advanced Energy
James McLawhorn, Public Staff of NC Utilities Commission
Steven McNulty, USDA Forest Service Southern Global Change Program*
Libby Smith, North Carolina Department of Commerce*
Dona Stankus, North Carolina Solar Center
Ralph Taylor, North Carolina State Construction Office
Jeff Tiller, Appalachian State University
Mitch Williams, Progress Energy
Matt Young, Cherokee Investments

David Von Hippel, CCS, TWG Facilitator
Alison Bailie, CCS, TWG Facilitator
Charles Davis, TWG Liaison, DENR/DAQ
Brock Nicholson, DENR/DAQ Coordinator

ENERGY SUPPLY

Caroline Choi, (replaced Vicky Will), Progress Energy*
Marion Deerhake, Environmental Management Commission*
James DeRosa, (Jim Haven), Global Warming Initiatives
Roy Ericson, NC Utilities Commission*
George Everett, Duke Energy*
Alex Hobbs, NCSU Solar Center*
Len Hoey, State Energy Office
Preston Howard, Manufacturer Chemical Industry Council*
Matthew Kanes, (Steve Lisk), Piedmont Natural Gas
Robert Koger, (Ward Lenz), Advanced Energy*
Thomas Lam, Public Staff of NC Utilities Commission
Pete McDowell, NC Waste Awareness and Reduction Network
Marily Nixon, Southern Environmental Law Center*

Simon Rich, Energy Industry & Duke University*
Michael Shore, (Ulla Reeves, Amy McDonald), Environmental Defense*
Jim Stephenson, NC Coastal Federation*
Tim Toben, Carolina Green Energy*
Ivan Urlaub, NC Sustainable Energy Association*
John Wilson, (Stephen Smith*), Southern Alliance for Clean Energy

Bill Dougherty, CCS, TWG Facilitator
Sivan Kartha, CCS, TWG Facilitator
Kimberly Garnett, TWG Liaison, DENR/DAQ
Jim Southerland, DENR/DAQ
Brock Nicholson, DENR/DAQ Coordinator
Charles Davis, DENR/DAQ

TRANSPORTATION AND LAND USE

Daren Bakst, John Locke Foundation
Dan Besse, Winston-Salem City Council*
Denise Choy, Environmental Defense
Anne Coan, NC Farm Bureau
David Farren, (Marily Nixon*), Southern Environmental Law Center
Dennis Grady, Appalachian State University*
Len Hoey, State Energy Office
Bill Holman, Clean Water Management Trust Fund, then Duke University, Nicholas Institute for Environmental Policy Solutions*
Scott Lane, Louis Berger Group
Carolyn McCormick, Outer Banks Visitors Bureau*
Maximilian Merrill, NC Department of Agriculture and Consumer Services
Simon Rich, Energy Industry & Duke University*
Lisa Riegel, NC Natural Heritage Trust Fund*
Roger Sheats, Global Warming Initiatives*
Nina S. Szlosberg, NC Board of Transportation*
Anne Tazewell, NC Solar Center Alternative Fuels
Jeff Tiller, Appalachian State University
Susan Tompkins, Community Volunteer
Skip Yeakel, Volvo Trucks North America*

William Schroeer, CCS, TWG Facilitator
Wendy Messenger, (Lewison Lem), CCS, TWG Facilitator/Assistants
Karl Hausker, CCS, TWG Facilitator
Phyllis Jones, TWG Liaison, DENR/DAQ
Brock Nicholson, DENR/DAQ Coordinator

AGRICULTURE, FORESTRY, AND WASTE MANAGEMENT

Stan Adams, NC DENR, Division of Forestry Resources (now retired, but active)*
John Bonitz, Rural Advancement Foundation and Southern Alliance for Clean Energy
Anne Coan, (Mitch Peele, Paul Sherman*) North Carolina Farm Bureau
Marion Deerhake, Environmental Management Commission*

Jim Durham, International Paper
Bob Hazel, Senior Citizens' Interest*
Dennis Hazel, NCSU, Forestry Extension*
Jim Hickman, NC Division of Pollution Prevention and Environmental Assistance
Bill Holman, Clean Water Management Trust Fund, then Duke University, Nicholas Institute for Environmental Policy Solutions*
Chris Hopkins, NCSU, Forestry Extension
Robert Jackson, Duke University, Nicholas School of the Environment and Earth Sciences*
Amy McDonald, Environmental Defense & Southern Alliance for Clean Energy
Steve McNulty, USDA Forest Service, Southern Global Change Program*
Maximilian Merrill, NC Department of Agriculture and Consumer Services*
David Mickey, Blue Ridge Environmental Defense League
Bob Slocum, North Carolina Forestry Association*
Stephen Smith, (Ulla Reeves) Southern Alliance for Clean Energy*
Jim Stephenson, NC Coastal Federation
Kraig Westerbeek, Murphy-Brown Farms*
Stephen Whitfield, North Carolina Woodlands*

Steve Roe, CCS, TWG Facilitator
Kathryn Bickel, CCS, TWG Facilitator
Heather Hawkins, TWG Liaison, DENR/DAQ
Jim Southerland, DENR/DAQ
Brock Nicholson, DENR/DAQ Coordinator

CROSS-CUTTING ISSUES

Dan Besse, Winston-Salem City Council*
Ryan Boyles, State Climatologist, (replaced Sethu Raman) NC Climate Office*
Thomas F. Cecich, Environmental Management Commission*
Dolores M. Eggers, Professor, UNC Asheville*
George Givens, Counsel, NC Senate – Manager of Legislative Commission on Global Climate Change*
Steve Kalland, NC Solar Center
Steven McNulty, USDA Forest Service, Southern Global Change Program*
Chuck Pickering, The Biltmore Estate*
Ulla Reeves, Southern Alliance for Clean Energy
Roger Sheats, (James DeRosa, Jim Haven), Global Warming Initiatives*
Larry Shirley, North Carolina State Energy Office*
Michael Shore, (Kathryn Eggers), Environmental Defense*
Libby Smith, NC Department of Commerce*
Jim Stephenson, NC Coastal Federation*
Susan Tompkins, Community Volunteer

Ken Colburn, CCS, TWG Facilitator
Randy Strait, CCS, TWG Facilitator
James Southerland, TWG Liaison, DENR/DAQ
Brock Nicholson, DENR/DAQ Coordinator
Janice Godfrey, DENR/DAQ

Appendix C
Greenhouse Gas (GHG) Emissions Inventory and Reference Case Projections

See the report entitled "Final North Carolina Greenhouse Gas Inventory and Reference Case Projections 1990–2020," dated September 2007, for detailed documentation. The report is available on the Climate Action Plan Advisory Group's website at http://www.ncclimatechange.us/capag.cfm.

Appendix D
Methods for Quantification

Draft Memo

To: North Carolina Climate Action Planning Advisory Group (CAPAG) and Technical Work Group (TWG) members
From: The Center for Climate Strategies (CCS)
CC: North Carolina Department of Environment and Natural Resources (DENR)
Re: Methods for quantification of draft greenhouse gas (GHG) mitigation option benefits and costs
Date: May 23, 2006

This memo describes in brief the methodology CCS uses in quantifying the GHG impacts and costs of policy options, and provides some examples of the distinction between "direct" and "indirect" costs. CCS uses the following methods, widely accepted among climate change mitigation policy analysts:

- Focus of analysis: Net GHG reduction potential in physical units of million metric tons carbon dioxide equivalent (MMTCO2e) and net cost per metric ton reduced in units of dollars/MTCO2e.

- Geographic inclusion: Measure GHG impacts of activities that occur within the state, regardless of the actual location of emissions reductions.

- Direct vs. Indirect Effects: Define "direct effects" as those borne by the entities implementing the option. For example, direct costs are net of any benefits or savings to the entity. Define "indirect effects" as those borne by the entities other than those implementing the option. Quantify these indirect effects on a case-by-case basis depending on magnitude, importance, need and availability of data. (See additional discussion and list of examples below.)

- Non-GHG (ancillary) impacts and costs: Include in qualitative terms where deemed important. Quantify on a case by case as needed depending on need and where data is readily available.

- Discounted and "Levelized" Costs: Discount costs using the discount rate applied by the State in other policy arenas (or apply a real discount rate of 5% if a state-approved rate is not available). Discount a multiyear stream of net costs (total costs net of any savings) to arrive at the "present value cost" of an option. Create a "levelized" cost per ton by dividing the "present value cost" by the cumulative reduction in tons of GHG. This is a

widely used method to estimate the "dollars per ton" cost of reducing GHG emission (all in CO2 equivalence). A "levelized" cost is a "present value average" used in a variety of financial cost applications.[1]

- Time period of analysis: Count the impacts of actions that occur during the project time period and, using levelized emissions reduction and cost analysis, report emissions reductions and costs for specific target years such as 2010 and 2020. Where additional GHG reductions or costs occur beyond the project period as a direct result of actions taken during the project period, show these for comparison and potential inclusion.

- Aggregation of impacts: Avoid simple double counting of GHG reduction potential and cost when adding options. Note and or estimate interactive effects between policy options using analytical methods where overlap is likely.

- Policy design specifications: Include timing, goal levels, implementing parties, and the type of implementation mechanism.

- Transparency: Include data sources, methods, key assumptions, and key uncertainties.

The approaches here do not necessarily take a "standard" benefit-cost perspective as used in regulatory policy impact analysis. For instance, there is no direct/indirect distinction under standard procedures: one takes the "societal perspective" and tallies everything, and quantifies where possible. Regarding GHG mitigation costs, often the best available data is focused at the level of implementation as opposed to the societal level. Regarding GHG benefits, market prices (monetized benefits) are normally taken as good proxies of societal costs and benefits in standard analysis unless there are market imperfections or subsidies that create distortionary effects. Because we do not have good information on the dollar value of GHG reduction benefits, we use physical benefits instead, measured as MMTCO2e.

The "direct cost" approach described here is useful in estimating the costs (and benefits) to the implementing entity: person, company, governmental body, etc. "Indirect costs" (and benefits) are those experienced by other entities in society. In examining utility Demand Side Management (DSM) programs for gas and electric utilities, analysts sometimes look at three perspectives: "participant", "non-participant", and "societal" (the latter being equivalent to "standard" benefit-cost perspective). Depending on program design, "direct cost" to a DSM participant can be high or low (if the latter, it may be attributable to a shifting of some costs non-participants).

Note also that the "direct cost" approach does not necessarily account for market imperfections or subsidies. Typically a state perspective on "direct costs" takes any federal government subsidies as a given. For example, substantial federal government subsidies exist for some

[1] For additional details and formulas, see www.tellus.org/energy/publications/policies&measures.pdf, p. 33, See especially the discussion of how some analysts advocate some form of discounting the multi-year stream of GHG reductions, while others do not.

alternative fuels. If the existing market price (with subsidy) of the alternative fuel is used in cost analysis, the option appears as relatively low cost. If the subsidy were included in the cost analysis (i.e., looking at societal costs in the standard benefit-cost perspective), then the alternative fuel would appear more costly.

Finally, some direct costs may look very large despite the attractiveness of the policy option for a variety of reasons, including co-benefits. For instance, in one state a bundle of Transit/Smart Growth/VMT Reductions was estimated to have a direct cost of $280/MTCO2e – a comparatively high figure -- but stakeholders still endorsed the policy option for the multiple benefits it would generate. In this case stakeholders also believed that a large state investment cost would have been incurred anyway for conventional transportation investment, and that redirection of part of this existing stream of funds to smart growth alternatives made sense. As an alternative assumption, the cost of the existing stream of transportation funds could have been treated as sunk, and the true cost measured instead as the incremental level of smart growth redirected funding over and above the BAU funding stream.

CCS will provide transparency on related data sources, methods and assumptions in its analysis of draft mitigation policy options to ensure that these issues are known, and rely on feedback from the TWGs and CCAG to identify any suggested modifications that may be needed. One key constraint we often face is the availability of data. It is not unusual for data to be imperfect and require pragmatism and transparency during analysis.

For additional reference we recommend the economic analysis guidelines developed by the Science Advisory Board of the US EPA available at: http://yosemite.epa.gov/ee/epa/eed.nsf/webpages/Guidelines.html.

Examples of Direct/Indirect Net Costs and Benefits, RCI

Direct Costs and/or Benefits

- Net capital costs (or incremental costs relative to standard practice) of improved buildings, appliances, equipment (cost of higher-efficiency refrigerator versus refrigerator of similar features that meets standards)
- Net O&M costs (relative to standard practice) of improved buildings, appliances, equipment, including avoided/extra labor costs for maintenance (less changing of CFL or LED lamp relative to incandescent)
- Net fuel (gas, electricity, biomass, etc.) costs (typically as avoided costs from a TRC or societal perspective)
- Cost/value of net water use/savings
- Cost/value of net materials use/savings (for example, raw materials savings via recycling, or lower/higher cost of low-GWP refrigerants)
- Direct improved productivity for as a result of industrial measures (measured as change in cost per unit output, for example, for an energy/GHG-saving improvement that also speeds up a production line or results in higher product yield)

Indirect Costs and/or Benefits

- Re-spending effect on economy
- Net value of employment impacts
- Net value of health benefits/impacts
- Value of net environmental benefits/impacts (value of damage by air pollutants on structures, crops, etc.)
- Net embodied energy of materials used in buildings, appliances, equipment, relative to standard practice
- Improved productivity as a result of an improved working environment, such as improved office productivity through improved delighting (though the inclusion of this as indirect might be argued in some cases)

Examples of Direct/Indirect Net Costs and Benefits, ES

Direct Costs and/or Benefits

- Net capital costs (or incremental costs relative to reference case technologies) of renewables or other advanced technologies resulting from policies
- Net O&M costs (relative to reference case technologies) renewables or other advanced technologies resulting from policies
- Avoided or net fuel savings (gas, coal, biomass, etc.)of renewables or other advanced technologies relative to reference case technologies resulting from policies
- Total system costs (net capital + net O&M + avoided/net fuel savings + net imports/exports + net T&D costs) relative to reference case total system costs

Indirect Costs and/or Benefits

- Re-spending effect on economy
- Higher cost of electricity reverberating through economy
- Energy security
- Net value of employment impacts
- Net value of health benefits/impacts
- Value of net environmental benefits/impacts (value of damage by air pollutants on structures, crops, etc.)

Examples of Direct/Indirect Net Costs and Benefits, AF

Direct Costs and/or Benefits

- Net capital costs (or incremental costs relative to standard practice) of facilities or equipment (e.g. manure digesters and associated infrastructure, generator; ethanol production facility)
- Net O&M costs (relative to standard practice) of equipment or facilities
- Net fuel (gas, electricity, biomass, etc.) costs or avoided costs
- Cost/value of net water use/savings

Indirect Costs and/or Benefits

- Net value of employment impacts
- Net value of health benefits/impacts
- Value of net environmental benefits/impacts (value of damage by air pollutants on structures, crops, etc.)
- Net embodied energy of water use in equipment or facilities relative to standard practice
- Reduced VMT and fuel consumption associated with land use conversions (e.g. as a result of forest/rangeland/cropland protection policies).

Examples of Direct/Indirect Net Costs and Benefits, TLU

Direct Costs and/or Benefits

- Incremental cost of more efficient vehicles net of fuel savings.
- Incremental cost of implementing Smart Growth programs, net of saved infrastructure costs.
- Incremental cost of mass transit investment and operating expenses, net of any saved infrastructure costs (e.g., roads)
- Incremental cost of alternative fuel, net of any change in maintenance costs

Indirect Costs and/or Benefits

- Health benefits of reduced air and water pollution.
- Ecosystem benefits of reduced air and water pollution.
- Value of quality-of-life improvements.
- Value of improved road safety.
- Energy security
- Net value of employment impacts

Appendix E
Residential, Commercial, and Industrial Sectors Mitigation Option Recommendations

Summary List of Mitigation Options

	Mitigation Option Name	GHG Reductions ($MMtCO_2e$)			Net Present Value 2007–2020 (Million $)	Cost–Effective–ness ($/tCO2e)	Level of Support
		2010	2020	Total 2007–2020			
RCI–1	Demand-Side Management Programs for the Residential, Commercial and Industrial Sectors Recommended Case: "Top-ten States" EE Investment	1.9	11.6	77.1	–1,895	–25	UC
RCI–2	Expand Energy Efficiency Funds	1.5	8.0	54.8	–1,346	–25	UC
RCI–3	Energy Efficiency Requirements for Government Buildings	0.0	1.1	6.4	–88	–14	UC
RCI–4	Market Transformation and Technology Development Programs	0.0	2.0	10.5	–339	–32	UC
RCI–5	Improved Appliance and Equipment Efficiency Standards	0.0	1.0	5.3	–336	–63	UC
RCI–6	Building Energy Codes	0.5	3.5	23.1	–400	–17	UC
RCI–7	"Beyond Code" Building Design Incentives and Targets, Incorporating Local Building Materials and Advanced Construction	0.7	5.2	34.2	–494	–14	UC
RCI–8	Education (Consumer, Primary/Secondary, Post-Secondary/ Specialist, College and University Programs)	*Not quantified*					UC
RCI–9	Green Power Purchasing (required for state facilities) and Bulk Purchasing Programs for Energy Efficiency or Other Equipment	0.1	0.5	3.5	11	3	UC
RCI–10	Distributed Renewable and Clean Fossil Fuel Power Generation	1.2	4.6	33.5	392	12	UC
RCI–11	Residential, Commercial, and Industrial Energy and Emissions Technical Assistance and Recommended Measure Implementation	0.5	2.1	14.9	–494	–33	UC
	SECTOR TOTAL AFTER ADJUSTING FOR OVERLAPS	5.3	33.0	218.7	–3,994	–18	N/A

	Mitigation Option Name	GHG Reductions ($MMtCO_2e$)			Net Present Value 2007–2020 (Million $)	Cost–Effectiveness ($/tCO_2e$)	Level of Support
		2010	2020	Total 2007–2020			
	REDUCTIONS FROM RECENT ACTIONS*						
RCI–1	Demand-Side Management Programs for the Residential, Commercial and Industrial Sectors	0.3	0.7	6.2			N/A
RCI–2	Expand Energy Efficiency Funds	0.2	0.4	3.6			N/A
RCI–6	Building Energy Codes	0.0	0.0	0.0			N/A
RCI–9	Green Power Purchasing (required for state facilities) and Bulk Purchasing Programs for Energy Efficiency or Other Equipment	0.0	0.0	0.3			N/A
	SECTOR TOTAL PLUS RECENT ACTIONS	5.8	34.2	228.8			N/A

UC = unanimous consent; N/A = not applicable.

Negative values in the Net Present Value and the Cost-Effectiveness columns represent net cost savings associated with the options.

* "Recent actions" represent initiatives undertaken in North Carolina that reduce GHG emissions that were implemented shortly before or during the CAPAG process. The emission reductions associated with recent actions are not accounted for in the GHG emissions inventory and reference case projections. Emissions reductions associated with these recent actions were therefore estimated separately, and are counted toward overall statewide reductions along with reductions from the mitigation options recommended by the CAPAG.

Notes

Substantial input on **Related Policies/Programs in Place** was provided by RCI TWG members, especially focusing on State Energy Office (SEO) and State Energy Plan (SEP) policies and programs. Because many of these policies and programs are relevant to more than one of the RCI Options, we have established Annex A (provided with analysis workpapers—Annex B—in a accompanying document) that provides detail on these policies and have retained only the titles of the policies in the "Related Policies/Programs section for the RCI individual options. SEO Contract refers to contracts currently in place with the State Energy Office for the services outlined. Note that SEO and SEP reference information may not yet have been included with all relevant options.

Acronyms

CAPAG	Climate Action Plan Advisory Group
CHP	combined heat and power
CO_2	carbon dioxide
CSA	Clean Smokestacks Act of 2002
DENR	Department of Environment and Natural Resources
DG	distributed generation
DSM	demand-side management
HVAC	heating, ventilation, and air conditioning
LPG	liquefied petroleum gas (propane/butane)
RCI	Residential, Commercial, and Industrial
SEO	State Energy Office
SEP	State Energy Plan
SWH	solar water heating
TWG	Technical Working Group

RCI-1. Demand-Side Management Programs for the Residential, Commercial, and Industrial Sectors

Mitigation Option Description

Utility-funded Demand-Side Management (DSM) programs reduce either the consumption of or the demand for conventional sources of electricity and fossil fuels. Examples of DSM programs include technical assistance for and implementation of energy efficiency and renewable energy measures, electrical (and in some cases fuel) demand responses, alternative rate schedules, and research activities. This option is designed to work in tandem with other strategies under consideration by the Residential, Commercial, and Industrial (RCI) Technical Working Group (TWG) and by other TWGs that can also encourage efficiency gains.

Mitigation Option Design

It is recommended that DSM programs funded by gas and electric utilities in North Carolina be expanded to yield higher levels of energy savings, demand response, and greenhouse gas (GHG) emissions savings.

Specific recommendations from the RCI TWG include proposing that the North Carolina General Assembly and the North Carolina Utilities Commission take an active role in encouraging the investor-owned, cooperative and municipal utilities to pursue active DSM programs.

Examples of utility-funded programs that this option supports include

Residential Building Programs

- Efficiency programs for new residences, such as ENERGY STAR®, Environments for Living, HealthyBuilt Home, LEED-H, or other programs.
- Efficiency programs for existing residences, such as Home Performance with ENERGY STAR. Development of this program should follow a comprehensive survey and analysis of existing residences to determine key strategies that will provide the greatest impact for the least investment.
- Renewable energy programs for new and existing residences.[1]
- Programs focused on low-income weatherization of new and existing homes (such as Systems Vision).
- Programs focused on rental properties.

[1] Including cost-effective alternatives to fossil-fuel-based energy, such as solar water heating, passive solar designs, solar space heating and pool heating (only to replace electric or fossil-fuel-based existing pool heating), residential biofuels, photovoltaics, and other strategies.

Commercial and Industrial Building Programs

- Efficiency programs for new commercial buildings, using commercial ENERGY STAR and LEED-NC as starting points.
- Efficiency programs for existing commercial buildings, using the work of the State Energy Office's Utility Savings Initiative, ongoing energy audit and technical services, and previous programs, such as the federally funded Institutional Conservation Program, and programs in other states, as additional sources.
- Efficiency programs for new and existing industrial facilities, based on ongoing efforts of North Carolina State's Industrial Energy Extension Service and Industrial Assessment Center, Advanced Energy's industrial efficiency programs, and other related projects.
- Renewable energy programs for new and existing commercial buildings and industrial facilities, with the same focus as renewable energy programs for new and existing residences.

Other Multi-sector Strategies

- Demand response and demand reduction programs for all sectors.
- Technical assistance, education, training, consumer outreach, and promotional activities to support the DSM programs.
- Grants, loans, performance contracting arrangements, and other incentive programs to provide financial support or incentives for implementation of DSM programs.

Goals: The goal for this option is to reach a level of DSM investment in North Carolina equal to 1.5% of utility revenues. This level of investment would have placed North Carolina among the top ten US States in DSM investment per unit electricity sales revenue, based on a national compilation of energy efficiency investment for the year 2003.[2]

Timing: Start ramping up programs from existing levels starting in 2007, reaching goal levels by 2012.

Parties Involved:

- Utilities: Through the rate-making process, utilities and the North Carolina Utilities Commission will develop a mechanism to include the cost of DSM programs in the respective utility's rate base, or provide for a separate surcharge that utility customers pay.
- State Agencies: The North Carolina Utilities Commission, the Public Staff, the State Energy Office, the Department of Environmental and Natural Resources, the State

[2] *ACEEE's 3rd National Scorecard on Utility and Public Benefits Energy Efficiency Programs: A National Review and Update of State-Level Activity.* By Dan York and Marty Kushler of the American Council for an Energy-Efficient Economy. Report No. U054, Dated October 2005. See also rankings presented in [2] *A Study of the Feasibility of Energy Efficiency as an Eligible Resource as Part of a Renewable Portfolio Standard for the State of North Carolina*, dated December 2006, and prepared as a report for the North Carolina Utilities Commission by GDS Associates, Inc.

Construction Office, and others shall be involved in the design and implementation of the DSM programs.

- Third-party Efficiency Providers: North Carolina has considerable expertise in its universities, nonprofit organizations, and private consulting and technical service companies to provide services for the DSM programs. The overall effort should seek to develop a statewide "efficiency industry" that will expand beyond the efforts of the DSM programs alone.
- Regulators: The North Carolina Utilities Commission, with input from the Public Staff, will likely be the approving and oversight body for the programs.
- Others: A wide variety of stakeholders will provide input into the development and continued operation of the DSM programs.

Implementation Mechanisms

Demand-Side Management programs around the country vary substantially, with dozens of different types of implementation mechanisms. Potential implementation mechanisms and supporting activities for this mitigation option include:

- Primary Implementation Mechanism—Utilities will develop and manage their own Demand-Side Management Programs, with input from the Utilities Commission and other stakeholders, and with approval from the Utilities Commission, and will include the expenses of the program in the overall rate base.[3]
- Overall Management—There are different options for overall management of utility programs:
  - Each utility manages its own programs.
  - Utilities contract with others (public agencies, non-profit agencies, and/or private contractors) to manage some or all of a utility's programs.
- Supporting Activities:
  - Direct payment incentive programs: Utility customers who implement specific efficiency or renewable measures receive partial rebates. For example, builders of ENERGY STAR homes receive an incentive of a given amount per square foot up to a maximum incentive.
  - Rebate programs: Utility customers who purchase energy efficient or renewable products receive an incentive payment upon submitting their purchase receipts.
  - Loan programs: Utility customers receive a preferential loan to finance the purchase of high efficiency HVAC systems for commercial buildings.
  - Preferential rates: Participants in load control programs or homebuyers who select (for example) ENERGY STAR homes receive lower rates.

[3] The Utilities Commission might also consider offering utility incentives to provide substantial programs.

- Marketing programs: Utilities purchase advertising to promote the DSM programs and recognize those who participate.[4]
- Technical service programs: Utilities provide directly, through the managing organization, or through subcontractors, technical assistance, analysis, and recommendations.
- Research and development (R&D) programs: Utilities support applied research which promises fairly quick implementation, such as high efficiency HVAC and humidity control systems, insulated/non-vented attics, improved commercial ventilation control strategies, and electricity generation from biomass.[5]

Related Policies/Programs in Place

- **SEO CONTRACT, Appalachian State University Energy Center.**
- **SEP Exec-11:** Reduction of energy consumption in State agencies and universities.
- Electric Utilities providing DSM programs include Progress Energy, Dominion Power, and Duke Energy. Programs are mostly information, with a few financing programs.[6] Gas utilities and other fuel provider organizations include Piedmont Natural Gas, Scana – Public Service Company North Carolina (PSCNC), North Carolina Propane Gas Association, North Carolina Petroleum Marketers Association, and Carolina Fuel Institute.
- At the 5/23 CAPAG meeting, the Environments for Living program was noted as an example, with builders having built 80,000 homes in the South and Southwest under the program in the last 5 years.[7] Also, it was noted that solar water heating is included in the NC Green Power Program.
- The NC HealthyBuilt Homes (HBH) program, supported in part by the NC State Energy Office, has been very active in the State.
- ENERGY STAR Homes is another example of building performance standards and certifications in use in North Carolina.
- Policy on net metering has been established by the NCUC, and corresponding tariffs approved.[8] The establishment of Small Generator Interconnection Standards is designed to streamline the process for customers seeking to install net metering applications, as well as other small renewable energy generation applications.[9]

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[4] Marketing on consumer products programs can include incentives, retailer training, marketing and promotion, education, and similar efforts.

[5] Such support can include funding of research and development for energy efficiency and renewable energy and could be implemented through R&D contracts with private firms, grants and contracts with universities, intramural R&D conducted at government labs, and R&D contracts with private/public consortia.

[6] Other ongoing programs in North Carolina that are relevant to this option include the Industrial Extension Service (IES) at NCSU, energy and water efficiency programs at the Division of Pollution Prevention and Environmental Assistance (DPPEA), Western Waste Reduction Partners (WRP) and other similar programs. The North Carolina State Energy Office also offers a number of programs in many sectors. See also http://www.seea.us/PDFs/SEEA_DSM.pdf.

[7] See http://www.efihome.com/

[8] See Docket No. E-100, Sub 83.

[9] See Docket No. E-100, Sub 101.

- Free refrigerator disposal programs already exist in North Carolina.
- In 1980, the NCUC established a systems benefit charge, creating a non-profit corporation to administer the funds with the charter "to encourage energy efficient economic development in North Carolina." The non-profit Advanced Energy operates programs for subsidized and market-rate home construction, and provides energy efficiency assistance to North Carolina industry.[10]
- The State Energy Office is involved in federal Industries of the Future. CSA recommendation A-5: Promote and Support Efforts to Establish North Carolina as a World Leader in GHG, Non- Carbon Fuels and Energy Efficiency Technologies SEP promotes further incentives for high efficiency motors.
- **SEO CONTRACT, Energy Management Program,** operated in conjunction with the North Carolina State University Industrial Extension Service.
- **SEO CONTRACT, The Center for Energy Research and Technology.**
- **SEO CONTRACT, Energy Efficiency for Nonprofits.**
- **SEO CONTRACT, ElectriCities—Energy Auditor.**
- **SEO CONTRACT, Energy Efficiency Field Assistance Waste Reduction Partners.**
- **SEO CONTRACT, Central and Eastern Waste Reduction Partners.**
- **SEP 7-4:** Develop performance contracting procedures and other ways to finance energy efficiency projects for state and local governments, university and public school systems, and public housing.
- Duke power has a special needs low-interest loan program for low-income residents for HVAC equipment and weatherization measures.

Type(s) of GHG Reductions

Principally, the reduction in GHG emissions (largely CO_2) from avoided electricity production and avoided on-site fuel combustion. Less significant are the reduction in CH_4 emissions from avoided fuel combustion and avoided pipeline leakage. Other GHG impacts are also conceivable, but are likely to be small (black carbon, N_2O) and/or very difficult to estimate (materials use, life cycle, market leakage, etc.).

Estimated GHG Reductions and Costs (or Cost Savings)

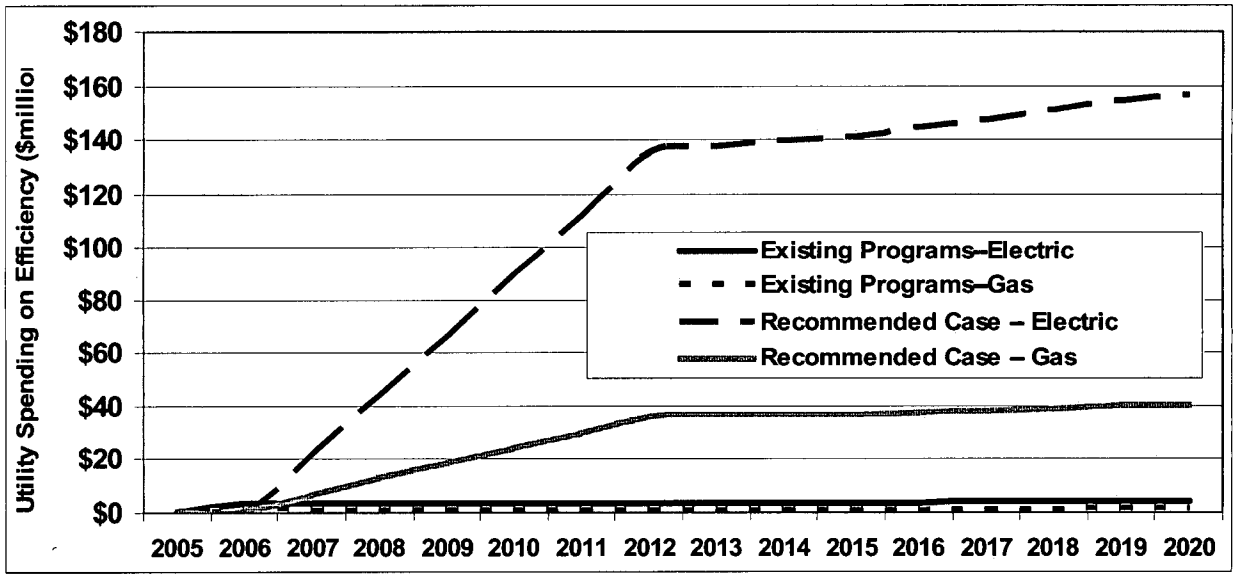
The table below shows the incremental savings of this option over and above any savings that are expected to accrue from current utility DSM programs in North Carolina. Figure E-1 compares the overall utility revenues devoted to energy efficiency programs under the RCI-1 option as analyzed (at spending levels required to offset growth in emissions). Please see Annex B to these descriptions for additional details of the analysis of this option.

Demand-Side Management Programs for the Residential, Commercial and Industrial Sectors	2010	2020	Units
Recommended Case: "Top-ten States" EE Investment			
GHG Emission Savings	1.9	11.6	$MMtCO_2e$

[10] See http://www.advancedenergy.org/

Net Present Value (2007–2020)		–$1,895	$ million
Cumulative Emissions Reductions (2007–2020)		77.1	$MMtCO_2e$
Cost-Effectiveness		–$25	$/tCO_2e$

Figure E-1. Comparison of overall utility revenues devoted to energy efficiency programs under RCI-1



Data Sources: Costs of DSM programs from a rough average of compilations of program experience for Northwest utilities and estimates for an energy efficiency program as part of a renewable portfolio standard in North Carolina[11] (electric) and from utility programs nationwide (gas).

Quantification Methods: The CAPAG suggests reviewing the interplay of approaches in RCI-1 through RCI-3 when analyzing these options.

Key Assumptions: Sufficient energy efficiency opportunities are available and achievable to offset growth in utility sales. Baseline growth in electricity sales are as included in the Inventory and Forecast prepared for the CAPAG.[12] Transmission and Distribution loss fractions are assumed to start at 6.3% of generation in 2006, and falling to 5.6% of generation by 2020. These values are consistent with those used for evaluation of energy supply options related to the electricity sector.

[11] GDS Associates, Inc. Report for the NC Utilities Commission, *A Study of the Feasibility of Energy Efficiency as an Eligible Resource as Part of a Renewable Portfolio Standard for the State of North Carolina,* dated December 2006.

[12] At the January 24 CAPAG meeting, a CAPAG member expressed doubts that sufficient generation and/or imports would be available in North Carolina to meet the future levels of electricity demand included in the baseline forecast.

Key Uncertainties

- North Carolina-specific costs of DSM programs at savings levels modeled.
- Levels of spending/savings from Existing DSM programs in North Carolina.
- Impact of electricity energy efficiency programs on peak demand as well as energy requirements.[13]

Additional Benefits and Costs

Benefits

- Reducing use of electricity and natural gas through this option also reduces emissions of local and regional air pollutants, such as sulfur and nitrogen oxides, which in turn reduce the human health and other impacts of those emissions.[14]
- Co-benefits include transmission/distribution system costs reduction

Costs

None cited.

Feasibility Issues

- Costs and performance vary substantially between measures that might be considered for DSM programs. Some measures may present low capital costs and higher operating costs (or vice versa), and there is uncertainty about the costs and savings for other measures.
- Interaction with appliance standards and utility programs.

Status of Group Approval

Completed.

Level of Group Support

Unanimous consent.

Barriers to Consensus

None.

[13] TWG members requested estimates of the impacts of RCI-1 and other options on peak power demand as well as on electric energy requirements. The magnitude of changes to peak power demand could affect both avoided costs and avoided GHG emissions associated with energy efficiency actions.

[14] Tools such as the EPA's COBRA (Co-benefits Risk Assessment Model) and BenMAP (Environmental Benefits Mapping and Analysis Program) can be used to obtain estimates for the economic benefits of reduction of non-GHG air pollutant emissions that accompany GHG emissions reduction.

RCI-2. Expand Energy Efficiency Funds

Mitigation Option Description

The public benefits charge (sometimes call systems benefits charge) is a fee assessed to utility customers based on their usage of energy in a given time period. With deregulation in many states, the utility commissions often lose the ability to require the electric utilities to have efficiency programs. The result in many states is the development of the public benefits charge, which is a non-bypassable charge on electric bills. The funds collected are then provided to a third party to provide energy efficiency programming.

Mitigation Option Design

It is recommended that North Carolina's existing Public Benefits Charge be significantly increased to support more investments in energy efficiency and renewable energy options. While the State has a well-established public benefits charge and fund, the charge to consumers has not changed since its inception in 1980. Since that time, other states have implemented public benefits charges that are significantly higher than in North Carolina. If North Carolina were to raise its public benefits charge to the level of the national average collected by other states, funds collected would be more than 20 times higher. The increased charge in other states has allowed them to take the lead and drive energy efficiency both locally and nationally.[15]

It is recommended that these increased public benefits charges be collected under the oversight of the NC Utilities Commission, and invested in residential, commercial, and industrial energy efficiency and renewable energy programs through one or more third-party administrators. Long-term consistency in management and dedicated application of funds collected via public benefits charges to the target programs will be crucial to the success of this initiative.

Investments in energy efficiency and renewable energy made using public benefits funds would be expected to span a wide variety of residential, commercial and industrial applications.[16]

Goals: Reduce GHG emissions from RCI activities by providing public benefit charges adequate to implement energy efficiency and renewable energy programs comparable to the more effective public benefits charge-funded programs in the United States. Information from a national compilation on existing and planned electric utility spending on energy efficiency programs in other states was reviewed, and indicated spending in the range from a fraction of

[15] Because almost all public benefit charges are currently assessed in cold weather states, the majority of research and program development has been directed to issues faced in the Northeast and Northwest. While some of these programs can be translated to North Carolina, many cannot, due to differing electric rates and climates. Unfortunately, there are no substantial public benefits programs in the Southeast, leaving the area shallow in terms of energy efficiency programs at a time when population growth is pushing electric demand to new highs.

[16] Applications could include (but would by no means be limited to) measures such as solar-powered (absorption) air conditioning, ground-source heat pumps, and efficiency improvement programs for window AC units, lighting, water heating, plug loads, networked PC management, power supplies, motors, pumps, boilers, and other appliances and equipment.

one percent to approximately three percent of utility revenues. On that basis, 1% of utility revenues was chosen as an appropriate public benefits charge goal for North Carolina at present.

Timing: Three-year phase-in of public benefits charges from the current level to a level consistent with the goals above.[17]

Parties Involved: The public benefits charge is collected from customers of all gas and electric utilities. The collected Public Benefits Funds is then spent on energy efficiency and renewable energy investments in all sectors. All relevant stakeholder groups are involved in the design, governance and oversight, management, and implementation of programs to invest these funds.

Implementation Mechanisms

As stated above, we believe the most effective implementation method is to work through the NC Utilities Commission to increase funding in the established program. While funding will increase, funding allocations do not have to stay the same.

Potential implementation mechanisms and supporting activities for this mitigation option include

- Provision of programs with substantial incentives for consumers to participate, and that include retailer training, marketing and promotion, education, and other elements designed to ensure program effectiveness.
- Funding of R&D for Energy Efficiency, Renewable Energy, and Other GHG Reduction Strategies. Funding from the Public Benefits Charge can in part be used for R&D contracts with private firms, grants and contracts with universities, intramural R&D conducted at government labs, and/or R&D contracts with private/public consortia.
- Performance-based Contracting for funding of energy efficiency improvements, with capital costs paid back through energy savings.
- Establishment of a Reinvestment Fund providing financing for energy-efficiency and other GHG emissions-reduction efforts. This fund would be used in part to create infrastructure to deliver energy-efficiency and renewable technologies. Allowing state agencies to keep the net savings from energy efficiency actions undertaken with the use of public benefits funds, or to reinvest savings in energy-efficiency or other projects, will be crucial to the success of fund initiatives in the public sector. The Reinvestment Fund can take the form of a Special capital fund for businesses developing renewable energy sources, such as the Pennsylvania "Energy Harvest" program.

Related Policies/Programs in Place

- North Carolina has the oldest public benefits charge program, established in 1980 by the NC Utilities Commission. The original intent of this program was to reduce electric demand in an effort to slow the need for new power plant construction. The current public benefits charge of 0.003567 cents per kWh translates to approximately three cents

[17] In other states, a dramatic increase in public benefits funding levels has led to severe growing pains as administration of such funding was difficult to develop. A 3-year plan of implementation can allow expectations to be more effectively set and realized.

per month per average residential customer in the State. The total collected amounts to about $3.5 million per year. These funds are used for energy efficiency and economic development programs throughout the state. Because of the small amount of funding, efforts have been specialized to serve specific markets in the state. Industrial motors and process heating receive much of the attention in an effort to make our industries more efficient and competitive, thereby retaining and building the job base. The other primary area of funding is the residential new construction sector.

- CSA recommendation LT-5, *Develop a Public Benefits Fund.*
- NCUC is presently investigating several issues involving DSM and Energy Efficiency in the current Integrated Resource Planning.[18] This investigation includes Public Benefit Funds.
- In 1980 the NCUC established a systems benefit charge, creating a non-profit corporation to administer the funds with the charter "to encourage energy efficient economic development in North Carolina." The non-profit Advanced Energy operates programs for subsidized and market-rate home construction, and provides energy efficiency assistance to North Carolina industry. [19]
- It was noted during the 5/23 CAPAG meeting that the NC Tax Credit for Renewable Technology Investment has "sunseted" (lapsed), and should be brought back (or replaced with a program with similar goals).
- **SEP Exec-8:** Reexamine existing legislation and regulations as pertains to barriers and strategies to develop wind energy while still protecting North Carolina's natural beauty.
- **SEP Exec-9:** Incentives and regulatory or administrative measures for development of renewable electricity generation facilities, solar water heating, passive and active solar space heating, and daylighting.
- **SEP Exec-13:** Facilitate efforts of local governments to finance energy efficiency and renewable energy projects.
- **SEP 4-1:** The North Carolina Utilities Commission is encouraged to promote policies that create diversity in energy supply such as natural gas, solar energy, wind energy, biomass, and hydrogen from renewable sources with particular emphasis on in-state energy development.
- **SEP 7-4:** Development of performance contracting procedures and other ways to finance energy efficiency projects for state and local governments, university and public school systems, and public housing.
- **SEP 8-6:** Continue its work to formulate and advance mortgage-based incentives for high performance new homes.
- **SEP 9-2:** Promotion and development of guidelines for performance contracts, conduct workshops, and provide technical assistance on developing performance contracting documents.

[18] See in Docket No. E-100, Sub 110.

[19] See http://www.advancedenergy.org/(6.9).

Type(s) of GHG Reductions

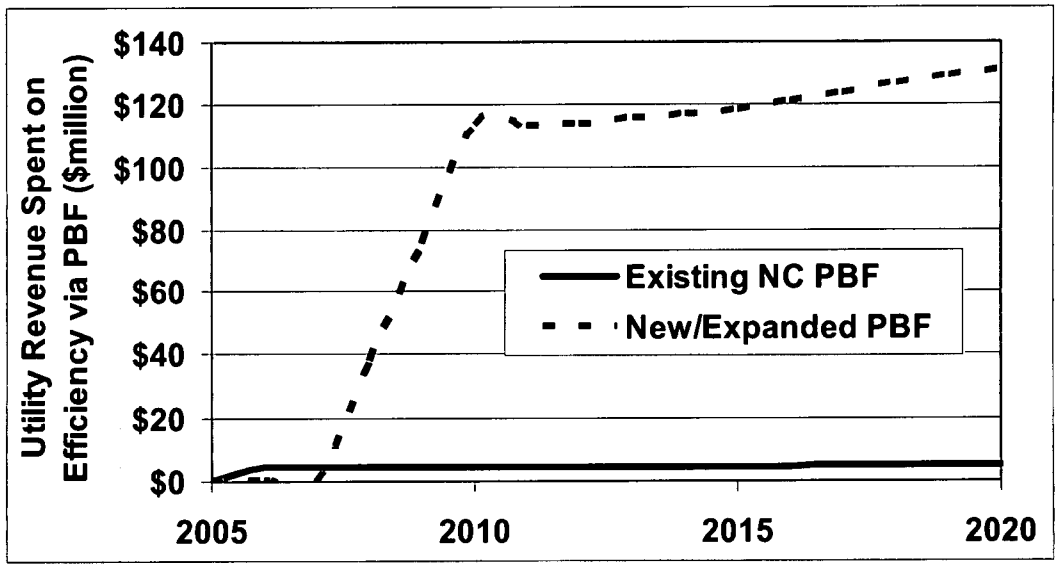
As with RCI-1, this option would principally yield reductions in GHG emissions (largely CO_2) from avoided electricity production and avoided on-site fuel combustion. Less significant are the reduction in CH_4 emissions from avoided fuel combustion and avoided pipeline leakage. Other GHG impacts are also conceivable, but are likely to be small (black carbon, N_2O) and/or very difficult to estimate (materials use, life cycle, market leakage, etc.).

Estimated GHG Reductions and Costs (or Cost Savings)

The table below shows the incremental savings of this option over and above any savings that are expected to accrue from the current public benefits program in North Carolina. Figure E-2 compares the overall utility revenues devoted to public benefits under the RCI-2 option as analyzed. Please see Annex B under these descriptions for additional details of the analysis of this option.

Expand Energy Efficiency Funds	2010	2020	Units
GHG Emission Savings	1.5	8.0	$MMtCO_2e$
Net Present Value (2007–2020)		–$1,346	$ million
Cumulative Emissions Reductions (2007–2020)		54.8	$MMtCO_2e$
Cost-Effectiveness		–$25	$/tCO_2e$

Figure E-2. Comparison of overall utility revenues devoted to public benefits under RCI-2



Data Sources: Costs of DSM programs from a rough average of compilations of program experience for Northwest utilities and estimates for an energy efficiency program as part of a

renewable portfolio standard in North Carolina[20] (electric) and from utility programs nationwide (gas).

Quantification Methods: The CAPAG suggests reviewing the interplay of approaches in RCI-1 through RCI-3 when analyzing these options.

Key Assumptions: 1% of utility electric and gas revenues are spent annually on public benefits programs (assumed mostly energy efficiency).

Key Uncertainties

- North Carolina–specific costs of energy efficiency investments at savings levels modeled.
- Future expected levels of spending vs. savings from public benefits charge program in North Carolina

Additional Benefits and Costs

Benefits

- Co-benefits could include transmission/distribution system costs reduction.
- Would help to provide local employment and grow renewable energy use.

Costs

None cited.

Feasibility Issues

- Costs for this option are uncertain, depending on measures included.
- Interaction with appliance standards and utility programs needs to be taken into account.

Status of Group Approval

Completed.

Level of Group Support

Unanimous consent.

Barriers to Consensus

None.

[20] GDS Associates, Inc. Report for the NC Utilities Commission, *A Study of the Feasibility of Energy Efficiency as an Eligible Resource as Part of a Renewable Portfolio Standard for the State of North Carolina,* dated December 2006.

RCI-3. Energy Efficiency Requirements for Government Buildings

Mitigation Option Description

Recognizing that governments should "lead by example" the option presented here provides energy use targets to improve the efficiency of energy use in State and local government buildings. This option sets energy-efficiency goals for the existing government building stock, as well as for new construction and major renovations of government buildings.

Mitigation Option Design

Elements of this Option Design include

- Adherence by new and renovated government buildings to the energy-related guidelines included in LEED + (Leadership in Energy and Environmental Design), a national building certification program that currently exists in the commercial building arena but would have **more explicit energy efficiency requirements** than LEED alone. Conversion of existing buildings to bring them into compliance with the LEED + standard.
- Revise the existing policy(s) that separates construction budgets from maintenance budgets. By linking these, the increased energy efficient construction or alterations will be seen as long term savings.
- Extend green campus initiatives to all public academic and government campuses.
- Energy benchmarking, measurement, and tracking programs for municipal and state buildings.
- Energy efficiency requirements for new, renovated, and existing government buildings.
- Renewable energy requirements for new, renovated, and existing government buildings.

Goals: New construction and major renovations of government buildings must meet LEED+ requirements. Commence with all buildings entering the design phase by 2010. Based on a state composite average, achieve a 20% reduction from a baseline fiscal year of 2002-03 in energy consumption per gross square foot per year for the entire North Carolina government existing building stock by 2027. In the last year of the program, establish a new 5-year goal for government building energy efficiency improvement.[21]

Timing: See the timing targets described in the "goals" section above. This option will build on the USI (Utility Savings Initiative) program already in place at the North Carolina State Energy Office.

Parties Involved:

[21] *Should this option cover public housing as well as other government buildings?*

- State agencies, UNC System and affiliates, Community College System and K-12 school districts.
- Local governments and other public entities.
- Building code enforcement.
- Architects, building designers, engineers, developers, builders, contractors.
- Regulators—State Construction Office, State Energy Office, Office of State Budget and Management.

Implementation Mechanisms

Potential implementation mechanisms and supporting activities for this mitigation option include:

- Performance-based Contracting (PC) for funding of energy efficiency improvements - Capital costs paid back through energy savings. Should the PC reach a payback period threshold in perhaps 12 or 15 years, or mandate PC contain a renewable energy component then funds are paid back.
- Create a Clearinghouse for information on and access to software tools to calculate impact of energy efficiency and renewable technologies for buildings.
- Energy technologies that should be promoted by this section include but are not limited to
  - Active and passive solar building technologies such as photovoltaic panels, solar hot water heaters, and solar-powered (absorption) air conditioning.
  - Support for new-to-market technologies, such as Solar Hybrid Lighting (using light guides to bring daylight into building interiors), where appropriate in select, potentially high profile, researched and monitored projects for future broad application.
  - Ground-source Heat Pumps.
  - Focus on specific end uses/technologies such as lighting, water heating, plug loads, networked computer management, power supplies, motors, pumps, boilers, and cool roofing.
- Carry out a comprehensive statewide survey of energy and water efficiency features in existing government buildings to provide information on the potential for energy efficiency in the NC government building stock.

Related Policies/Programs in Place

- The Environments for Living program[22] is an example of the types of improvements included in this option, with builders having built 80,000 homes in the South and Southwest under the program in the last 5 years. Also, solar water heating is included in the NC Green Power Program.
- The NC HealthyBuilt Homes (HBH) program, supported in part by the NC State Energy Office, has been very active in the State.

[22] See http://www.eflhome.com/

- ENERGY STAR Homes is another example of building performance standards and certifications in use in North Carolina.
- The State Energy Office is involved in federal Industries of the Future. CSA recommendation A-5: "Promote and Support Efforts to Establish North Carolina as a World Leader in GHG, Non- Carbon Fuels and Energy Efficiency Technologies."
- **SEP Exec-11:** Reduction of energy consumption in State agencies and universities.
- **SEP Exec-15:** The General Assembly should review options, such as a Public Benefits Fund (PBF) or other means, to enable funding of the recommendations in the State Energy Plan.
- **SEP Exec-20:** The State Energy Office should organize a statewide effort to develop criteria for a residential high performance building program to reduce the life cycle cost of new and existing buildings.
- **SEP 6-1:** Development of a Solar Schools Program.
- **SEP 7-1:** North Carolina statutes should require that designers of all new public buildings provide estimates of projected energy consumption and energy costs for the building prior to construction.
- **SEP 7-3:** Implementation of high performance building guidelines developed for North Carolina in all new public buildings and for new public housing.
- **SEP 7-7:** Local governments should be encouraged to implement SEP recommendations and other energy efficiency programs.
- **SEP 8-3:** The State Energy Office should encourage new manufactured homes to comply with the critical components of the state energy code for site-built residential units and promote ENERGY STAR manufactured homes.
- **SEP 9-4:** The State Energy Office should promote the use of and provide training for commercial building energy analysis software.

Type(s) of GHG Reductions

As with RCI-1 and RCI-2, this option would principally yield reductions in GHG emissions (largely CO_2) from avoided electricity production and avoided on-site fuel combustion. Less significant are the reduction in CH_4 emissions from avoided fuel combustion and avoided pipeline leakage. Other GHG impacts are also conceivable, but are likely to be small (black carbon, N_2O) and/or very difficult to estimate (materials use, life cycle, market leakage, etc.).

Estimated GHG Reductions and Costs (or Cost Savings)

Energy Efficiency Requirements for Government Buildings	2010	2020	Units
GHG Emission Savings	0.0	1.1	$MMtCO_2e$
Net Present Value (2007–2020)		–$88	$ million
Cumulative Emissions Reductions (2007–2020)		6.4	$MMtCO_2e$
Cost-Effectiveness		–$14	$/tCO_2e$

Data Sources: Costs of energy efficiency improvements based on studies of costs of building improvements and code changes.

Quantification Methods: Estimates fractional savings in energy intensities needed, after code improvements, in new and existing government buildings. Allocates intensity savings among energy efficiency, renewable energy sources.

Key Assumptions: Fractions of electric and gas intensity improvement accounted for by efficiency improvements, solar thermal, solar PV, and/or increased biomass use; fractional savings target of 20% over new code levels.

Key Uncertainties

- Total government building space in North Carolina (regional estimates currently used with state building floor area data to estimate total government building floorspace—state, local, county, and schools).[23]
- Fraction of government agencies occupying leased space in North Carolina (estimate of 10% of government-owned building space used).
- Rate of building renovations versus new construction in the government sector (estimate of 30% used based on consideration several national and regional sources).

Additional Benefits and Costs

Benefits

Co-benefits could include transmission/distribution system costs reduction.

Costs

None cited.

Feasibility Issues

- Costs for this option are uncertain, depending on the measures included.
- Potential interaction with appliance standards and utility programs.

Status of Group Approval

Completed.

Level of Group Support

Unanimous consent.

Barriers to Consensus

None.

[23] Data compiled from NC State Property Office indicates total gross floor area of state-owned buildings in North Carolina of approximately 106 million square feet as of 2006. Summary data provided by Len Hoey of the NC State Energy Office.

RCI-4. Market Transformation and Technology Development Programs

Mitigation Option Description

A market transformation program is designed to create a situation where the bulk of the private market automatically adopts or incorporates technologies or techniques that result in improved energy efficiency. The goal of a market transformation and technology development program is to put energy efficiency technologies and practices into a position where they will be demanded by the public and chosen by builders and manufacturers. Methods of transformation will be different for each technology or technique, but often revolve around public and private review of quality and effectiveness, including partnerships between government agencies, retailers, manufacturers, and non-governmental agencies.

Mitigation Option Design

The intent of a market transformation program is to ensure that voluntary standards are rigorous enough to set a high bar while being understandable and valuable to the buyer. Market transformation efforts also often go hand-in-hand with technology development efforts.

A market transformation and technology development program must be long-term and robust. There must be CONSISTENT and enduring support for technology improvement and incorporation. There must be continued investment in technology development and integration. There must be independent evaluation of the efficacy of the technologies.

This particular recommendation is broadly defined and does not address a single technology or market. Rather, it addresses a method for bringing appropriate technologies and processes to the marketplace. Defined as such, it is recommended that several technologies be included in market transformation strategies for North Carolina, though others can and should be included as well.

- Promote the appropriate use of NEMA Premium motors and drives in industrial applications.
- Provide support for implementation of renewable energy applications such as solar water heaters.
- Target the early retirement of older appliances using a "bounty" program.
- Provide support for processes that recover waste heat from industrial applications.
- Promote the use of ground-source heat pumps by helping to identify and qualify appropriate applications.
- Encourage increased funding for ENERGY STAR to identify and qualify a greater number of products under their labeling.
- Encourage and enable smaller purchasers to act in aggregate groups to reduce costs and quantify emission reduction benefits from technology and process improvements.
- Provide a continuous funding level for near-term research and deployment of energy efficient technologies and processes.

Goals: Because this recommendation involves policy process rather than a specific emissions reduction technology, the goals will be different and dependent on the selected technologies included in the programs. A goal of any policy in this area is to provide consistent support with the end-result being a time when the support can be removed without the program benefits ending as well. Thus, the goal is to permanently transform markets to increase and accelerate the uptake of products with higher energy efficiency and of renewable energy products, working through a regional alliance that achieves savings similar to those achieved in other regions of the United States.

Timing: This mitigation option recommendation requires consistent and long-term thinking. Successful examples of transformation programs in other areas of the country were years and decades in the making. Set up agency/agencies in 2010. Start activities in 2012.

Parties Involved: All sectors and stakeholders in the state may be involved in market transformation programs, including:

- Retailers.
- Utilities.
- Manufacturers.
- Non-profit consortia.
- Consumers association.
- Professional associations (engineers, builders, architects, designers).
- State agencies.

Implementation Mechanisms

Implementation of market transformation programs requires the participation and buy-in of industry partners, regulatory bodies and consumer groups. Potential implementation mechanisms and supporting activities for this mitigation option include

- Collaborative marketing of energy efficiency and renewable energy technologies.
- Specific implementation measures mentioned as possible for this option include tax credits, low/no interest loans, and similar financial incentives to business, industries and commercial firms to upgrade their equipment (including manufacturing and pollution control equipment) to more energy-efficient technologies. The latter approach is especially important for small manufacturers, and can mean access to micro-loans.
- Funding of R&D for Energy Efficiency, Renewable Energy, other GHG Reduction Strategies.
- Could include patent protection, R&D tax credits, production subsidies or tax credits to firms bringing new technologies to market, tax credits or rebates for new technology buyers, government procurement, and demonstration projects.
- Market transformation is an area where the State Energy Office might be funded to contribute.

Related Policies/Programs in Place

- There are several related programs in place that can be modeled for other technologies and processes. One such program is run by the North Carolina Housing Finance Agency (NCHFA). The NCHFA provides training to their non-profit builders such as Habitat for Humanity affiliates. Further, the NCHFA provides a program where organizations may receive funds to participate in an energy guarantee program for new homes, if the homes are tested and achieve certain performance levels. More than 1,000 homes in North Carolina are part of this program, which is now being replicated in other states.
- **SEO CONTRACT Appalachian State University Energy Center.**
- A program exists in North Carolina to dispose of a refrigerator for free.
- **SEP Exec-1:** The North Carolina Department of Commerce and the State Energy Office should encourage and support economic development of energy-related enterprises whose products are intended to increase energy efficiency or use renewable resources.
- In 1980 the NCUC established a systems benefit charge, creating a non-profit corporate to administer the funds with the charter "to encourage energy efficient economic development in North Carolina." The non-profit Advanced Energy operates programs for subsidized and market-rate home construction, and provides energy efficiency assistance to North Carolina industry.[24]
- State Energy Office is involved in federal Industries of the Future. CSA recommendation A-5: Promote and Support Efforts to Establish North Carolina as a World Leader in GHG, Non- Carbon Fuels and Energy Efficiency Technologies. SEP recommends further incentives for high efficiency motors.
- **SEO CONTRACT PEM Fuel Cell.**
- **SEO CONTRACT Landfill Gas Conference.**
- Energy Improvement Loan Program.
- NC Weatherization Assistance Program, for low income earners; SEP recommends extending weatherization.

Type(s) of GHG Reductions

GHG impacts are similar in nature to those noted for RCI-1 through RCI-3 above.

Estimated GHG Reductions and Costs (or Cost Savings)

Energy Efficiency Requirements for Government Buildings	2010	2020	Units
GHG Emission Savings	0.0	2.0	$MMtCO_2e$
Net Present Value (2007–2020)		–$339	$ million
Cumulative Emissions Reductions (2007–2020)		10.5	$MMtCO_2e$
Cost-Effectiveness		–$32	$/tCO_2e$

Data Sources: Market transformation program costs and performance based on programs and experience of the Northwest Energy Efficiency Alliance.

[24] See http://www.advancedenergy.org/

Quantification Methods: Apply program results in percent savings, from other regions, to North Carolina.

Key Assumptions:

- Market transformation programs can reduce electricity demand by 0.2% annually.
- The implementation must be timed correctly.

Key Uncertainties

It is unknown the degree to which other states in the region will join with North Carolina to increase program effectiveness.

Additional Benefits and Costs

Benefits

- The non-energy and non-emission benefits are almost always going to be the economic drivers behind the success of these programs. Focusing only on emission reductions or only on payback through energy efficiency of the user will eliminate many technologies when they could otherwise provide substantial economic benefits. An example is an improvement to an industrial production line that may have negligible overall energy consumption reduction at the plant, but that decreases the energy consumption per unit produced (energy intensity) while speeding up production and retaining jobs in the state.
- Co-benefits could include transmission/distribution system costs reduction.
- Programs could help to lower capital and installation costs.

Costs

None cited.

Feasibility Issues

Interaction with appliance standards and utility programs.

Status of Group Approval

Completed.

Level of Group Support

Unanimous consent.

Barriers to Consensus

None.

RCI-5. Improved Appliance and Equipment Efficiency Standards

Mitigation Option Description

Appliance efficiency standards reduce the market cost of energy efficiency improvements by incorporating technological advances into base appliance models, thereby creating economies of scale. Appliance efficiency standards can be implemented at the state level for appliances not covered by federal standards, or standards can be jointly developed by multiple states.

Mitigation Option Design

This mitigation option involves the replication of standards adopted in other states for appliances not covered by federal standards. It also involves the State, working together with other states in the region, advocating for stronger federal appliance efficiency standards where this is technically feasible and economically justified. Of these options for coverage, implementation of stronger-than-federal standards together with other states, including states in the Southeast region, is much preferred by the CAPAG, as it provides a broader market for manufacturers and thus lowers net costs of higher-efficiency devices to North Carolina consumers.

Elements of this option design include

- Development of committee or other working group to develop recommendations on appliance standards (similar to existing group for building codes).
- Adoption of State-level Appliance Efficiency Standards, defined sufficiently broad enough to include, for example, commercial sector, and information technology (IT) equipment.
- North Carolina voices support for adoption of more stringent federal-level appliance efficiency standards.
- Design a standard for recycling of materials in appliances.
- Include water use reduction as a criterion for appliance efficiency improvement.

Goals: Increase stringency of appliance standards to the level of those recommended by the Appliance Standards Awareness Program.[25]

Timing: Adopt new standards by 2010. Standards in force by 2012.

Parties Involved: State agencies to enforce state codes and standards.

[25] See www.standardsasap.org. The analysis recommends standards for the following products: bottle-type water dispensers, commercial boilers, commercial hot food holding containers, compact audio products, DVD players and recorders, liquid immersion distribution transformers, medium voltage dry-type distribution transformers, metal halide lamp fixtures, pool heaters, portable electric spas, residential furnaces and boilers, residential pool pumps, single voltage external AC to DC power supplies, state-regulated incandescent reflector lamps, walk-in refrigerators and freezers.

Implementation Mechanisms

Potential implementation mechanisms and supporting activities for this mitigation option include:

- Appliance Standards promulgated by legislation or developed administratively.
- Assistance programs to help low-income consumers with purchase of appliances meeting more stringent standards, so as to reduce the higher-first-cost burden of higher-efficiency appliances on those consumers.
- Elevated energy standards for appliances and equipment purchased by public agencies.
- Work with manufacturers and consider impacts on manufacturers when setting new standards.

Related Policies/Programs in Place

- State Energy Plan (SEP) recommends ENERGY STAR from 2008 on.
  - The state is an ENERGY STAR Partner.
- Existing Federal Appliance Efficiency Standards (2005 Energy Bill).
- **SEP 7-6:** North Carolina Department of Administration should require that all state facilities with motors larger than 5 horsepower must develop a motor maintenance program.
- **SEP 10-3:** North Carolina should evaluate whether facilities that repair or rewind motors should be certified or otherwise meet a state efficiency requirement.
- **SEP 10-5:** North Carolina should create investment tax credits and other incentives for new and/or retrofitted manufacturing equipment to encourage modernization and efficiency improvements.
- **SEP 10-9:** The State Energy Office should sponsor workshops on industrial energy efficiency around the state directed at industrial facility operators, design and process engineers, and owners.

Type(s) of GHG Reductions

GHG impacts are similar in nature to those noted for RCI-1 through RCI-3 above.

Estimated GHG Reductions and Costs (or Cost Savings)

Improved Appliance and Equipment Efficiency Standards	2010	2020	Units
GHG Emission Savings	0.0	1.0	$MMtCO_2e$
Net Present Value (2007–2020)		–$336	$ million
Cumulative Emissions Reductions (2007–2020)		5.3	$MMtCO_2e$
Cost-Effectiveness		–$63	$/tCO_2e$

Data Sources: Fractional savings and costs drawn from ASAP and ACEEE, 2006. "Leading the Way: Continued Opportunities for New State Appliance and Equipment Efficiency Standards."

Quantification Methods: Results for North Carolina from report above adapted by adjusting for different analysis period, discount rate, and energy prices.

Key Assumptions: Costs and savings from efficiency improvement via standards will be similar in North Carolina to those indicated in the ASAP/ACEEE report.

Key Uncertainties

It is unknown the degree to which other states in the region will join with North Carolina in setting higher-than-federal standards so as to increase effectiveness and practical application of standards.

Additional Benefits and Costs

Benefits

Reduction in water use for some appliance upgrades.

Costs

None cited.

Feasibility Issues

Feasibility enhanced by ongoing efforts in nearby states.

Status of Group Approval

Completed.

Level of Group Support

Unanimous consent.

Barriers to Consensus

None.

RCI-6. Building Energy Codes

Mitigation Option Description

Building energy codes specify minimum energy efficiency requirements for new buildings or for existing buildings undergoing a major renovation. As energy use in buildings in North Carolina accounts for about one-third of North Carolina's current gross GHG emissions, amending State and/or Local Building Codes to make the requirements for minimum energy efficiency levels in buildings more stringent will have a considerable immediate and ongoing impact in reducing building-sector GHG emissions.

Mitigation Option Design

North Carolina has building energy codes modeled on the International Energy Conservation Code 2000 for residential and commercial buildings, and enforced by the Building Code Council. An ongoing process of code amendments for new and renovated residential and commercial buildings is proposed as follows.

- North Carolina should adopt more stringent building codes to improve the efficiency of energy use in buildings. North Carolina can use cost-effectiveness tests to identify where moving beyond national building codes makes economic sense. Also, the state can make improvements in codes including but not limited to heating, ventilation, and air conditioning (HVAC) systems, daylighting design to reduce lighting needs, electric lighting design, building envelope design, and using integrated building design strategies.
- North Carolina should move toward adopting innovative features of advanced codes being implemented in other states, such as lighting efficiency requirements in new homes that go beyond the codes in force, as appropriate to conditions in the State.
- Statewide enforcement of both existing and new building codes should be improved at all levels, and enforcement should be fully implemented within 6 months of statewide code adoption (if applicable).
- North Carolina should regularly update its energy codes. A 3-year cycle could be timed to coincide with the release of national model codes.
- As appropriate, codes should be modified to remove obstacles to renewable energy use, daylighting and non-conventional energy-efficient building materials in buildings where applicable.
- Include programs of education for building inspectors and other building industry professionals to assure that the new codes are implemented and enforced.

Goals:

- Enforce existing building energy codes by 2008.
- Establish a new energy code by 2010 that requires new North Carolina residences and commercial/industrial buildings to be 20% more efficient than buildings meeting current national building energy codes, and assure that the new code is enforced.

Timing: Updated every 6 months when the national energy code changes.

Parties Involved:

- North Carolina Department of Insurance, who can implement new codes.
- State and Local government building code enforcement agencies.
- Mobile Home Manufacturing Industry and Building Industry Associations in discussion of this issue.

Implementation Mechanisms

Potential implementation mechanisms and supporting activities for this mitigation option include

- Coordination with consumer products programs, possibly including incentives, retailer training, marketing and promotion, education, etc.
- Develop Training and Education programs for:
  - Builders and Contractors (such as related to HVAC sizing, duct sealing, energy analysis program, C&D waste recycling, renewable energy system installation, water distribution systems).
  - Trade School and Community College Students (for example, including the skills noted above skills in curricula).
  - Building Code and other Officials in Energy Code Enforcement.
- Develop a clearinghouse for information on and access to software tools to calculate the impacts of energy efficiency and solar technologies for buildings.

Related Policies/Programs in Place

- North Carolina has building energy codes modeled on IEC 2000 for residential and commercial and enforced by Building Code Council; SEP R-4 recommends reviewing compliance and potential improvement. Analyses of building code improvements have been undertaken by Jeff Tiller at ASU. Building codes are enforced by the Building Code Council and the North Carolina Department of Insurance.
- Latest information on Department of Insurance Web site indicates ASHRAE 90.1 2004.
- Advanced Energy Corporation, NC Solar Center, and others have ongoing programs in this and similar areas.
- Training of Building Code and other Officials in Energy Code Enforcement (Recommended in State Energy Plan).
- Advanced Energy Corporation is currently reviewing nine calculators for assessing building energy efficiency and solar technologies for buildings. Availability of tools could be widened.
- In 1980 the NCUC established a systems benefit charge, creating a non-profit corporation to administer the funds with the charter "to encourage energy efficient economic development in North Carolina." The non-profit Advanced Energy operates programs for

subsidized and market-rate home construction, and provides energy efficiency assistance to North Carolina industry.[26]

- State Energy Office is involved in federal Industries of the Future. CSA recommendation A-5: *Promote and Support Efforts to Establish North Carolina as a World Leader in GHG, Non- Carbon Fuels and Energy Efficiency Technologies,* SEP recommends further incentives for high efficiency motors.
- NC Weatherization Assistance Program, for low income earners SEP recommends extending weatherization.
- **SEP Exec-14:** The State Energy Office should develop programs, in addition to weatherization, to address energy-efficient housing in the low-income sector.
- **SEP Exec-20:** The State Energy Office should organize a statewide effort to develop criteria for a residential high performance building program to reduce the life cycle cost of new and existing buildings.
- **SEP 7-1:** North Carolina statutes should require that designers of all new public buildings provide estimates of projected energy consumption and energy costs for the building prior to construction.
- **SEP 7-3:** The North Carolina Department of Administration should implement high performance building guidelines developed for North Carolina in all new public buildings and new public housing.
- **SEP 8-1:** The State Energy Office should conduct a study on current compliance levels of residential and commercial buildings with the North Carolina state energy code.
- **SEP 8-2:** The State Energy Office should create an Energy Code Enforcement Assistance Program to provide additional energy code enforcement and outreach officials to serve across the state.
- **SEP 8-3:** The State Energy Office should encourage new manufactured homes to comply with the critical components of the state energy code for site-built residential units and promote ENERGY STAR manufactured homes.
- **SEP 8-7:** The State Energy Office should provide training on high performance buildings to building professionals in a number of different classifications.
- **SEP 9-1:** The State Energy Office should work with appropriate state agencies to provide a design review service that focuses on energy-efficient components and holistic, high-performance, design strategies for new commercial buildings.
- **SEP 9-4:** The State Energy Office should promote the use of and provide training for commercial building energy analysis software.
- Integration with Regional Demand Response Initiatives/recommendations is a SEP recommendation.

Type(s) of GHG Reductions

- CO_2 reduction from avoided electricity production and avoided on-site fuel combustion.

[26] See http://www.advancedenergy.org/ (6.9).

- Modest reduction in CH_4 emissions from avoided fuel combustion and avoided natural gas pipeline leakage, relatively small reductions in N_2O, Black Carbon emissions from avoided fuel consumption.

Estimated GHG Reductions and Costs (or Cost Savings)

Building Energy Codes	2010	2020	Units
GHG Emission Savings	0.5	3.5	$MMtCO_2e$
Net Present Value (2007–2020)		–$400	$ million
Cumulative Emissions Reductions (2007–2020)		23.1	$MMtCO_2e$
Cost-Effectiveness		–$17	$/tCO_2e$

Data Sources: Building Code Assistance Project (BCAP) analyses by state (including North Carolina) to derive base savings.

Quantification Methods: Apply general BCAP method to estimate code savings, but apply 20% target savings figure.

Key Assumptions: Average costs of building code improvements, ratio of gas improvements to electricity improvements.

Key Uncertainties

It is unknown, if renovations will be included in building energy code requirements. In addition, data on the annual amount of commercial and residential renovated floorspace were not found, so an estimate of 0.3 units of renovated commercial floorspace per unit new commercial floorspace (based on national and regional estimates) was used, and renovated residential floorspace was not considered in the analysis.

Additional Benefits and Costs

Benefits

Potential to also yield water savings, comfort/air quality improvements.

Costs

None cited.

Feasibility Issues

Interaction with appliance standards and utility programs.

Status of Group Approval

Completed.

Level of Group Support

Unanimous consent.

Barriers to Consensus

None.

RCI-7. "Beyond Code" Building Design Incentives and Targets, Incorporating Local Building Materials and Advanced Construction

Mitigation Option Description

Energy use in existing buildings and in non-government-funded new buildings must be substantially improved. This mitigation option provides incentives and targets to induce the owners and developers of new and existing non-government buildings to markedly improve the efficiency with which energy and other resources are used in those buildings, along with provisions for raising targets periodically and resources to help achieve the desired building performance. This option includes elements to encourage the improvement and review of energy use goals over time, and to encourage flexibility in contracting arrangements to encourage integrated energy and resource efficient design and construction.

Mitigation Option Design

Elements of this Option Design include

- Promotion and Incentives for "beyond code" construction, using programs of various types for various sectors:
  - o It is important to focus programs for building energy efficiency and renewable, clean, safe energy on specific market segments such as existing residential construction (weatherization), new home construction, apartments, low income housing, commercial new construction, commercial renovation construction, and others.
  - o Improved design and construction standards and guidelines addressing multiple aspects of resource conservation, with a focus on energy. Examples of such standards include the following:

— LEED (Leadership in Energy and Environmental Design, a national building certification program) which is currently mature in the commercial building arena but which includes fairly minimal energy requirements in its current version. The newer "LEED plus Massachusetts" standard includes more explicit energy efficiency requirements.

— NC HealthyBuilt Homes, a statewide residential green building certification program with ENERGY STAR as the energy efficiency base and additional energy requirements for the building envelope/comfort systems/appliances, lighting, and use of renewable energy. This includes IAQ requirements to ensure that EE does not jeopardize human health.

— ENERGY STAR Homes (a standard focused on energy efficiency for the building envelope and comfort systems).

— Environments for Living (a national residential energy efficiency certification program focused on large builders with some indoor air quality features).

  - o Energy technologies that should be promoted by this section include but are not limited to: active and passive solar building technologies, photovoltaic Panels on new

commercial buildings and many new homes, solar hot water heaters on homes and other buildings[27], new and existing building energy technologies, such as Solar Hybrid Lighting, where appropriate, particularly in select, potentially high profile, researched and monitored projects for future broad application, solar-powered (absorption) air conditioning for residential and commercial applications, ground-source heat pumps, high-efficiency boilers, and cool roofing.

- Energy education should be promoted under this option in coordination with the programs noted in RCI-8. (See Implementation Mechanisms, below.)

Goals:

- **Incentives** induce 5% of new residential buildings and 2% of new commercial buildings annually to go to "beyond code" energy use levels that improve energy performance over the average new building (that meets the upgraded building code) by 30%. These numbers will, on average, decrease energy use by 30% across the board above the existing building code requirements and encourage significant examples throughout the state of various building types that use 50% or less energy than is supported by the existing building code.[28]
- Incentives are provided to upgrade 20% of existing buildings by 2015 as follows:
  - Residential building energy performance improvements must increase by 15%.
  - Commercial building energy performance improvements must increase by 20%. This increase in efficiency should bring 20% of existing buildings up to the standard of the 2003 IECC (the current NC code, not the improved codes).

Timing: Ramp up program starting in 2007 to full effectiveness by 2012, except where noted otherwise.

Parties Involved:

- State governments, local governments and other public entities (leading by example, largely via RCI-3).
- Building code enforcement.
  - Architects, building designers, engineers, developers, builders, contractors.
  - Retailers of energy-efficient products.
  - Manufacturers of alternative building products.

[27] Note that the inclusion of solar technologies here may overlap with programs recommended under other RCI options.

[28] It should be noted that a 30% reduction is cost-effective given basic improvements in design, materials, and equipment but a 50% reduction in energy use requires a much heavier investment cost and will often require the use of renewable energy strategies (depending on building orientation, placement, or exposure). This effort is focused on supporting and growing the market of building professionals in our state who can perform this work for three reasons in addition to decreasing GHG emissions: 1) increase availability of capable building professionals for consumers wishing to increase energy performance, 2) increase market competition in energy performance improvements, and 3) provide a base for energy security as energy resources become more expensive and/or scarce.

Implementation Mechanisms

Potential implementation mechanisms and supporting activities for this mitigation option include

- Performance-based contracting for funding of energy efficiency improvements, with capital costs paid back through energy savings.
- The CAPAG recommends that the TWG suggest potential sources of funds to provide incentives for "green building" design and implementation.
- Streamlined application procedures for green building-related improvements.
- Comprehensive state survey of energy and water efficiency features in existing residential and commercial buildings to provide information on the potential for energy efficiency in North Carolina buildings.
- Implementation of a Clearinghouse for information on and access to software tools to calculate impact of energy efficiency and solar technologies for buildings.
- Energy benchmarking, measurement, and tracking programs for privately-owned buildings.
- Energy education that should be promoted under this option, in coordination with the programs noted in RCI-8 and including but not limited to:
    - Training and Education for Building Construction Phase Professionals (e.g., HVAC sizing, duct sealing, energy analysis program, C&D waste recycling, renewable energy system installation, and water distribution systems).
    - Support for growth and health of the residential building performance specialist industry.
    - Continuing Education for Building Design Phase Professionals, including architects, engineers, developers, contractors, urban planners, and realtors.
    - Energy efficiency, renewables and related education introduced at community colleges and trade schools.
- Building codes could include a recommendation that existing homes and commercial buildings at resale are upgraded to meet an energy efficiency standard, and financing programs be provided to help with the costs of those upgrades. If implemented, such a recommendation could be formulated so that only cost-effective savings would be included, and coordinated with lender and education consumer programs to spur the offering of "green mortgages" for qualifying properties, and to demonstrate overall lower ongoing cost-of-ownership for upgraded buildings.

Related Policies/Programs in Place

- The Energy Independence Act, S2051 filed May 2006, requires facility projects that receive state funding to reduce energy purchases by 20% by 2015.
- NC Green Building Technology database provides searchable database on case studies.
- S2001, H1272 required state government to review the use of High Performance Building guidelines in 7 buildings.

- Examples of existing programs: NC Healthy Built Homes, Healthy Building Resource Center Environments for Living in addition to those listed, groups offering programs and other services related to building energy efficiency and related programs include CERT at NCA&T, Appalachian State, Southern Research Institute, RTI, and others.
- SEP recommends:
  - ENERGY STAR home requirements by county.
  - Energy efficient mortgages.
  - Develop further programs to support privately funded projects.
  - Require high performance building standards for permits to build privately funded school projects.
- Advanced Energy Corporation and NC Solar Center, and others have ongoing programs in this and similar areas.
- Advanced Energy Corporation is currently reviewing nine calculators for assessing building energy efficiency and solar technologies for buildings. Availability of tools could be widened.
- At the 5/23CAPAG meeting, the Environments for Living program[29] was noted as an example, with builders having built 80,000 homes in the South and Southwest under the program in the last 5 years. Also, it was noted that solar water heating is included in the NC Green Power Program.
- In 1980 the NCUC established a systems benefit charge, creating a non-profit corporate to administer the funds with the charter "to encourage energy efficient economic development in North Carolina." The non-profit Advanced Energy operates programs for subsidized and market-rate home construction, and provides energy efficiency assistance to North Carolina industry.[30]
- State Energy Office is involved in federal Industries of the Future. CSA recommendation A-5: "Promote and Support Efforts to Establish North Carolina as a World Leader in GHG, Non- Carbon Fuels and Energy Efficiency Technologies". SEP recommends further incentives for high efficiency motors.
- SEP recommends state procurement of environmentally preferable products.
- NC Weatherization Assistance Program, for low income earners SEP recommends extending weatherization.
- Extend green campus initiatives to all university Buildings is a SEP recommendation.
- Energy benchmarking, measurement, and tracking programs for municipal and state buildings is a SEP recommendation.
- **SEO CONTRACT, The Center for Energy Research and Technology.**
- **SEP Exec-20 (formerly 8-4):** The State Energy Office should organize a statewide effort to develop criteria for a residential high performance building program to reduce the life cycle cost of new and existing buildings.

[29] See http://www.eflhome.com/
[30] See http://www.advancedenergy.org/

- **SEP 7-3:** The North Carolina Department of Administration should implement high performance building guidelines developed for North Carolina in all new public buildings and for new public housing.
- **SEP 8-3:** At a minimum, the State Energy Office should encourage new manufactured homes to comply with the critical components of the state energy code for site-built residential units and promote ENERGY STAR manufactured homes.
- **SEP 8-5:** The State Energy Office should develop a comprehensive, statewide promotional campaign for high performance buildings.
- **SEP 8-6:** The State Energy Office should continue its work to formulate and advance mortgage-based incentives for high performance new homes.
- **SEP 8-7:** The State Energy Office should provide training on high performance buildings to building professionals in a number of different classifications.
- **SEP 8-8:** The State Energy Office should provide training for building professionals on specific targeted technologies including residential daylighting, solar water heating, heat pump water heaters, new insulation products, and advanced HVAC systems and controls.
- **SEP 9-1:** The State Energy Office should work with appropriate state agencies to provide a design review service that focuses on energy-efficient components and holistic, high-performance, design strategies for new commercial buildings.

Type(s) of GHG Reductions

- CO_2 reduction from avoided electricity production and avoided on-site fuel combustion.
- Modest reduction in CH_4 emissions from avoided fuel combustion and avoided natural gas pipeline leakage, relatively small reductions in N_2O, Black Carbon emissions from avoided fuel consumption.

Estimated GHG Reductions and Costs (or Cost Savings)

"Beyond Code" Building Design Incentives and Targets, Incorporating Local Building Materials and Advanced Construction	2010	2020	Units
GHG Emission Savings	0.7	5.2	$MMtCO_2e$
Net Present Value (2007–2020)		–$494	$ million
Cumulative Emissions Reductions (2007–2020)		34.2	$MMtCO_2e$
Cost-Effectiveness		–$14	$/tCO_2e$

Data Sources: Costs of energy efficiency improvements based on studies of costs of building improvements and code changes.

Quantification Methods: Estimates fractional savings in energy intensities needed to meet targets in new commercial and residential buildings. Allocates intensity savings among energy efficiency, renewable energy sources.

Key Assumptions: Fractions of electric and gas intensity improvement accounted for by efficiency improvements, solar thermal, solar PV, and/or increased biomass use; fractional savings targets over (new) code levels; growth in housing stock.

Key Uncertainties

- Total commercial building space in North Carolina (regional estimates currently being used).
- Total renovated commercial space included in option per unit new commercial space (current estimate used is 0.3, based on regional and national studies).
- Fractions of new commercial buildings, and residential units, participating in program.

Additional Benefits and Costs

Benefits

Potential to also yield water savings, comfort/air quality improvements.

Costs

None cited.

Feasibility Issues

Interaction with appliance standards and utility programs.

Status of Group Approval

Completed.

Level of Group Support

Unanimous consent.

Barriers to Consensus

Not applicable.

RCI-8. Education (Consumer, Primary/Secondary, Post-Secondary/Specialist, and College and University Programs)

Mitigation Option Description

This mitigation option reflects the realization that the effectiveness of emissions reduction activities in many cases depends on providing information and education to consumers, as well as to future consumers (primary and secondary school students), regarding the energy and GHG emissions implications of consumer choices. In addition, in order to effectively implement many of the other RCI options above, specific and targeted education, outreach, and licensing requirements will be required for professionals in a variety of building-related trades in order to ensure that those professionals have the expertise to support aggressive GHG mitigation options in North Carolina.

Mitigation Option Design

Elements of this Option Design include

- Training and education for builders and contractors (such as in HVAC sizing, duct sealing, building energy analysis, waste recycling, renewable energy system installation, and water distribution systems).
- Training of building code and other officials in energy code enforcement.
- Energy Management Training/Training of Building Operators.
- Continuing Education for building Design Professionals, including architects, engineers, developers, contractors, urban planners, and realtors.
- Energy efficiency and related education introduced at community colleges and trade schools.
- Consumer education programs (probable overlap with recommendations of the Cross-Cutting TWG).
- Continued funding to meet the expanding role of the State Energy Office as a key consumer information outlet.
- Emphasize provision of resources directing consumers to information and technologies for energy-efficiency and climate impacts reduction.
- Introduce in School Curriculum (probable overlap with recommendations of Cross-Cutting TWG).

Goals: Implement training and education as described above in support of other RCI options. When implemented, more quantitative goals may be defined for the activities included in this option, such as number of persons trained in a given area. For example, goals can be quantified by identifying the number of trade professionals who go through a training program each year, the number of credits/courses offered, the number of students reached, or the fractions of applicants receiving specific types of training.

Timing: Education/Training options in place to coincide with needs to support other options recommended by the CAPAG.

Parties Involved:

- Code enforcement agencies.
- Building professional trade groups.
- Community colleges.
- Universities.
- Primary/secondary schools.
- Public information agencies.

Implementation Mechanisms

The following are potential implementation mechanisms and supporting activities for this mitigation option:

- Include coverage of energy efficiency topics in the exam for general contractors.
- Include coverage of energy efficiency topics in continuing education and recertification course and exams for public school teachers.

Related Policies/Programs in Place

- Advanced Energy Corporation and NC Solar Center, and others have ongoing programs to train and educate builders and contractors and offer training in similar areas.
- Training of building code and other officials is recommended in State Energy Plan.
- SEP recommends training programs for state building operators and for private building operators.
- CSA Recommendation A-7: "Public Education on Climate Change."
- NC Air Aware provides info for teachers, focus on ozone.[31]
- **SEO CONTRACT Energy Management Diploma.**
- **SEO CONTRACT Consumer Energy Education Program.**
- **SEO CONTRACT Building Operator Certification.**
- **SEO CONTRACT National Energy Education Development.**
- **SEO CONTRACT, Sustainable Design Competition.**
- **SEO CONTRACT, RFP for Utility Accounting Services.**
- **SEO CONTRACT, State Energy Office Information and Referral Center.**
- **SEP 6-1:** Development of a Solar Schools Program.
- **SEP 6-2:** The State Energy Office can work with the state's professional licensing boards to develop a certification program for renewable energy installers.

[31] See http://daq.state.nc.us/airaware/

- **SEP 8-7:** The State Energy Office can provide training on high performance buildings to building professionals in a number of different classifications.
- **SEP 8-8:** The State Energy Office can provide training for building professionals on specific targeted technologies including residential daylighting, solar water heating, heat pump water heaters, new insulation products, and advanced HVAC systems and controls.
- **SEP 9-4:** The State Energy Office can promote the use of and provide training for commercial building energy analysis.
- **SEP 10-9:** The State Energy Office can sponsor workshops on industrial energy efficiency around the state directed at industrial facility operators, design and process engineers, and owners.
- **SEP 12-1:** Develop and sponsor training programs for community colleges and universities in fields related to energy efficiency and high performance buildings.
- **SEP 12-2:** Assist in the coordination of energy education programs with museums and help create an energy museum "on wheels" using existing resources, such as the Science House at NCSU or the Museum of Life Science, wherever possible.
- **SEP 12-3:** Sponsor regional "renewable demonstration centers" or, whenever possible, use existing ones, e.g., demonstration centers such as the North Carolina Solar House and the EnergyXchange, and museums such as the Museum of Life and Science, and Discovery Place.
- **SEP 12-4:** Create energy internships or apprenticeships for graduating college students and high school students to create the next generation of energy professionals.
- **SEP 12-5:** Provide a statewide award, e.g., a college scholarship for the most outstanding energy-related science demonstration or experiment at the state science fair.
- **SEP 12-6:** Help the Education Departments of colleges and universities develop coursework for junior and senior undergraduates and graduate students in energy education.
- **SEP 12-7:** Help Community Colleges and other vocational schools develop coursework in energy efficiency and renewable energy to help spur the industry; such as training carpentry students in energy efficient, passive solar building design and construction. Include this training in voc-tech courses in high schools.
- **SEP 12-8:** Provide training to licensed professionals in the homebuilding industry focusing on energy efficiency and renewable energy sources to promote industry awareness and implementation of these technologies.
- **SEP 12-9:** Support development of a comprehensive information outreach program for consumer questions about saving energy and using renewables in their homes and businesses.
- **SEP 12-10:** North Carolina should encourage schools to reduce school operating budgets by installing energy efficiency and renewable energy systems.
- **SEP 12-12:** The State Energy Office should work in partnership with the State Department of Public Instruction to plan school energy-related initiatives and include a representative for energy-use in school facilities on the Energy Policy Council.

- **SEP 12-15:** The North Carolina Community College System should require that the community colleges' curricula provide a building science course, an energy design course for drafting programs, and a solar and or renewable energy technology class.
- **SEP 12-14:** Sponsor a program to install solar equipment or other sustainable energy technologies on school buildings in every school district in the state.
- **SEP 12-16:** Establish a central repository for energy information.

Type(s) of GHG Reductions

These education and information programs are crucial in enabling and supporting GHG emissions reductions in a number of RCI areas, but their direct GHG reduction impacts are very difficult to assess.

Estimated GHG Reductions and Costs (or Cost Savings)

As this education option is primarily in support of many other options in the RCI and other sectors, quantitative savings and costs results are not evaluated here.

Key Uncertainties

Not directly applicable.

Additional Benefits and Costs

Benefits

None cited.

Costs

None cited.

Feasibility Issues

Potential contribution of consumer education programs to reducing GHG emissions is difficult to estimate.

Status of Group Approval

Completed.

Level of Group Support

Unanimous consent.

Barriers to Consensus

None.

RCI-9. Green Power Purchasing (Required for State Facilities) and Bulk Purchasing Programs for Energy Efficiency or Other Equipment

Mitigation Option Description

"Green power" supplements the state's existing power supply with electricity generated from renewable resources like the sun, wind and organic matter. This option expands an existing voluntary North Carolina program by making green power purchases mandatory for State facilities. Also included in this option is a program for the bulk purchase of appliances and equipment with higher-than-standard energy efficiency by public agencies, and for the organization of similar bulk-purchase programs in the private sector.

Green power differs from a Renewable Portfolio Standard (RPS) in that the RPS requires that electric utilities provide a certain level of renewable energy in their generation mix, while green power allows consumers to set the level of renewable energy used to provide the electricity they consume.

Mitigation Option Design

It is recommended that the use of "green power" in North Carolina be significantly expanded, and that public- and private-sector programs for the bulk purchase of high-efficiency appliances and equipment be developed.

NC GreenPower is an existing program that accepts financial contributions from North Carolina citizens and businesses to help offset the cost to produce green power. There are several options that can be implemented that would greatly increase the scope and effectiveness of the program.[32] A number of suggestions designed to mandate the use of green power in state buildings, and to encourage the development of both demand for and supply of green power in the private sector, are provided under "implementation measures", below.

Goals: State facilities purchase energy through NC GreenPower or a similar green power provider to cover 20% of their power needs by 2018, over and above the requirements of renewable generation within an Environmental Portfolio Standard or similar requirement applying to electricity suppliers. This goal would be phased in starting in 2008.

As an assessment of the adequacy of North Carolina's renewable resources to provide the required green power for this option, the December, 2006 version of the La Capra report[33] lists (Table ES-2) a total renewable electricity resource potential ("practical energy potential") of

[32] NC GreenPower is an independent, nonprofit organization established to improve North Carolina's environment through voluntary contributions toward renewable energy. A landmark initiative approved by the NC Utilities Commission, NC GreenPower is the first statewide green energy program in the nation supported by all the state's utilities. NC GreenPower is entirely voluntary, with the revenue going toward paying incremental costs of renewable energy generation.

[33] *Analysis of a Renewable Portfolio Standard for the State of North Carolina, Technical Report,* prepared by La Capra Associates for the North Carolina Utilities Commission, and dated December 2006. Document available as http://www.ncuc.commerce.state.nc.us/rps/NC%20RPS%20Report%2012-06.pdf

16,700 GWh per year by 2017, excluding capacity from offshore wind or solar PV generating resources. This potential is somewhat more than the total renewable electricity required by this and other RCI options, plus the total renewable electricity required by the sum of all Energy Supply TWG options.

Goals for bulk purchase program: Address purchase of 10% of electricity-consuming equipment purchased annually by state agencies, and 1% of electricity-consuming equipment purchased annually by all commercial/institutional sector consumers. Devices purchased under bulk purchase program consume 20% less electricity, on average, than devices that would otherwise have been purchased.

Timing: Build on the existing NC GreenPower to reach the goals above. Develop bulk purchasing programs by 2010, and ramp up to full capacity by 2018.

Parties Involved: State facilities, electric utilities, renewable energy producers, electricity consumers, and buyers of energy-using appliances and equipment.

Other: Ensure that the economic value of renewable energy generation produced in the state is included in value judgments along with air quality and other benefits.

Implementation Mechanisms

Potential implementation mechanisms and supporting activities for this mitigation option include mechanisms targeted to increasing green power demand and supply, and mechanisms that can increase the bulk purchase of high-efficiency appliances and equipment. Some of these mechanisms are described below:

The following are suggestions for state policies that are designed to increase both supply and demand for green power, thus increasing the climate change mitigation efforts. Most recommendations are also designed to improve economic development in the state.

Demand-Side Recommendations:

- In order to demonstrate leadership in this area, state facilities can be mandated to purchase a certain percentage of their power as green power (for example, through NC GreenPower or a similar agency).
- The state can provide economic development incentives for new or expanding businesses to purchase green power, and tax credits to companies that purchase green power or that support green power purchases by their employees.
- The state can provide incentives for home builders to include one year of green energy with the purchase of new homes.
- The state can provide assistance and participation in consumer and business marketing programs for green power.
- The NC Department of Environment and Natural Resources can work with the US Environmental Protection Agency to ensure that green power is an option for air quality violator restitution.

- The state can ensure that the air quality benefits of renewable energy programs such as green power purchase are wedded to other benefits such as waste reduction, GHG emission reductions, and economic development.

Resource-Side Recommendations:

- The state can provide support for research efforts on, and feasibility studies of, new and developing renewable energy technologies. This support is designed to foster new technology business in the state.
- The state can provide a mechanism for long-term contract guarantees for renewable energy producers through green power programs. Currently, it is difficult to get financing for some projects due to the lack of long-term contracts.
- The state can provide support for larger renewable energy development projects. In the current program, energy is purchased after customers have signed up for the program. By sponsoring large developments prior to customer sales, the program will have more options and sales tools.
- The state can work to ease ridge laws in the mountains to allow for wind energy development. Further, the state can work with the military to provide for wind energy development in coastal areas currently being blocked.
- The state can provide low or no interest loans for qualified developers of renewable energy projects.
- Green power purchase programs will interact with supply-side RPS (renewable portfolio standard) options, and thus their development and evaluation will need to be coordinated with Energy Supply group Mitigation Options.

For implementation of equipment and appliance bulk-purchase programs,

- Develop a list of typical bulk purchases and use this to identify which purchases to target for energy efficiency improvements.
- Bulk purchasing programs can interact with utility programs. It may be useful to use these programs in combination with standards for appliance purchases by state agencies.

Related Policies/Programs in Place

- **SEO CONTRACT, NC GreenPower Marketing.** The North Carolina GreenPower Program has been in place for approximately 3 years. It solicits voluntary contributions from utility customers for use in subsidizing green power purchases in North Carolina (TWG member input).
- **SEO CONTRACT, Heat Pumps in Manufactured Homes.**
- SEP recommends state procurement of environmentally preferable products.
- **SEP 7-5:** State agencies can lead by example by establishing a certain minimum level of electricity to be derived from renewable sources, such as the North Carolina GreenPower Program, or via installation of state-owned renewable energy projects.
- **SEP 7-6:** North Carolina Department of Administration can require that all state facilities with motors larger than 5 horsepower must develop a motor maintenance program.

- **SEP 10-3:** North Carolina can evaluate whether facilities that repair or rewind motors should be certified or otherwise meet a state efficiency requirement.
- **General Statute 143, Article 3B:** Energy Conservation in Public Facilities. Part 1. Energy Policy and Life Cycle Cost Analysis. **143-64.10. through 143-64.16.**

Type(s) of GHG Reductions

GHG impacts are similar in nature to those noted for RCI-1 through RCI-3 above.

Estimated GHG Reductions and Costs (or Cost Savings)

Green Power Purchasing (required for State facilities) and Bulk Purchasing Programs for Energy Efficiency or Other Equipment	2010	2020	Units
GHG Emission Savings	0.1	0.5	$MMtCO_2e$
Net Present Value (2007–2020)		$11	$ million
Cumulative Emissions Reductions (2007–2020)		3.5	$MMtCO_2e$
Cost-Effectiveness		$3	$\$/tCO_2e$

Data Sources: CBECS (USDOE EIA Commercial sector survey), incremental cost of green power from existing programs in Western US.

Quantification Methods: Apply green power requirements to State facilities, fraction of non-state buildings. For bulk purchase program, assume fraction of building energy use covered, rate of replacement of devices, and savings due to purchase of higher-efficiency devices, and apply to State and non-State electricity use.

Key Assumptions: Incremental cost for green power: $25/MWh in 2006, declining by 2017 to the average incremental cost of an estimated $16.71, associated with the 10% Renewable Portfolio Standard (for an "expanded" RPS without energy efficiency) as modeled by La Capra Associates for North Carolina.[34] Net cost of bulk purchase programs are assumed similar to net cost of market transformation programs for this initial analysis. State building electricity consumption estimate. Assumption that non-State government buildings are NOT covered by green power targets under this option.

Key Uncertainties

- Degree of coverage of State and private sector participation/purchases of electrical equipment under the in bulk purchase program, and average savings from devices purchased under the program.

[34] *Analysis of a Renewable Portfolio Standard for the State of North Carolina, Technical Report,* prepared by La Capra Associates for the North Carolina Utilities Commission, and dated December 2006. Document available as http://www.ncuc.commerce.state.nc.us/rps/NC%20RPS%20Report%2012-06.pdf

Additional Benefits and Costs

Benefits

- In some cases green power has been more resistant to cost swings than conventional power.
- If power purchased through a green power is produced inside the state, there are also economic development benefits.

Costs

None cited.

Feasibility Issues

None cited.

Status of Group Approval

Completed.

Level of Group Support

Unanimous consent.

Barriers to Consensus

None.

RCI-10. Distributed Renewable and Clean Fossil Fuel Power Generation

Mitigation Option Description

Distributed generation with clean power systems reduces fossil fuel use and GHG emissions as well as providing electricity system benefits. Implementation of these systems should be encouraged through a combination of regulatory changes and incentive programs. This option is targeted at small to medium-sized facilities, generally less than 10 MW.

Mitigation Option Design

It is recommended that implementation of distributed renewable and clean fossil fuel power generation systems of less than 10 MW be encouraged through a combination of regulatory changes and incentive programs. The following are elements of this Option Design:

- Review existing net-metering policies, including policies that affect electricity consumers who install on-site combined heat and power or distributed generation fueled with renewable or fossil fuels. Consider the impact of NO_x and power factor requirements on net-metering and availability of information for small customers.
- Review rate issues in NC, including decoupling of utility revenues from sales and rate design, with a specific focus on the impacts of rate design on GHG emissions.
- Provide incentives for renewable energy applications such as photovoltaics and other renewable power sources, including tax incentives.
- Promote clean combined heat and power in all sectors. New and existing technologies allow CHP to be used in residential, commercial sectors as well, so these sectors should be included.[35] CHP included here will emphasize smaller generation capacities.
- Fund R&D for distributed renewable and clean fossil fuel power generation.
- Provide direct or indirect support for in-state commercialization and production of new or advanced technologies for distributed renewable and clean fossil fuel power generation.
- Encourage the development of building-integrated distributed renewable and clean fossil-fuel power generation.

Goals: Implementation of 25%–33% of North Carolina's CHP potential by 2020. An additional 2%–4% of all NC homes will have SHW installations by 2020. 35 additional MW of distributed renewable generation over and above RPS-related new generation by 2020.

Timing: Implement changes in regulation necessary to encourage technologies by 2008. Implement incentive program by 2008.

[35] Examples cited at the 5/23 CAPAG meeting include stacks of newly developed ½ watt fuel cells, 1-kW residential CHP providing hot water, and micro-turbines for residential and small commercial applications. CHP options to be encourages may also include the use of waste heat from new electricity generation units to substitute for fossil-fueled heat in the RCI sectors. In some cases of industrial CHP, it may be necessary to assess the impact of CHP presence on given distribution circuit.

Parties Involved: Encouraging the development of distributed renewable and clean fossil-fueled generation will require coordination and cooperation among a number of different parties, including (but not limited to)

- Regulators (North Carolina Utilities Commission, DENR, US EPA).
- Utilities.
- Other state agencies.
- Industry associations.
- Equipment suppliers/vendors/installers, building professionals, and engineers.
- R&D associations.

Implementation Mechanisms

Potential implementation mechanisms and supporting activities for this mitigation option include

- Incentives to reduce first cost to a specific payback level can be coupled with requirements for new buildings. Specific implementation measures mentioned as possible for this option include tax credits, low/no interest loans, and similar financial incentives to business, industries and commercial firms to adopt CHP/distributed generation/renewables. The latter approach is especially important for small manufacturers, and could just be access to micro-loans.
- Echoing implementation mechanisms developed for options ES-3 and ES-9 by the Energy Supply TWG, support for development of CHP systems could include:
    - Encouragement CHP systems of 20 MW or smaller (or of equivalent mechanical power) by a rapid adoption and customer-friendly implementation of FERC Order 2006 for Standardization of Small Generator Interconnection Agreements and Procedures;
    - Qualify heat use from CHP systems for existing renewable and energy efficiency incentive and loan programs;
    - Allow energy service companies to sell CHP and consumer-sited distributed generation output to third party customers; and
    - Facilitate governmental and non profit organizations to easily sell renewable energy credits and tax credits to the market place.
- Support for switching to less carbon-intensive energy resources (coal and oil to natural gas or biomass, electricity to solar water heating or space/process heat).
- Voluntary Emissions Targets for Industrial Operations.
- Can include CHP/distributed generation-related/renewables R&D contracts with private firms, grants and contracts with universities, Intramural R&D conducted at government labs, R&D contracts with private/public consortia.
- Can include patent protection, R&D tax credits, production subsidies or tax credits to firms bringing new CHP/distributed generation-related/renewables technologies to

market, tax credits or rebates for new technology buyers, government procurement, and demonstration projects.

- Include methane capture and use in CHP systems at sewage treatment plants as a specific focus.
- Consider integration of distributed generation options with regional demand response initiatives/recommendations.

Expanded use of distributed renewable and clean fossil-fueled power generation in North Carolina will need to be accompanied by reviews of related regulations. Such reviews could include

- Review of net-metering policies, e.g., electricity consumers who install on-site combined heat and power or distributed generation fueled with renewable or fossil fuels. This review could consider the impact of NO_x and power factor requirements on net-metering and availability of information for small customers.
- Utility Rate Reform—At the CAPAG Meeting on 5/23/06, it was suggested that there is a need to look harder at rate issues in North Carolina, including decoupling of utility revenues from sales and rate design, with a specific focus on the impacts of rate design on GHG emissions.

Related Policies/Programs in Place

- Policy on net metering has been established by the NCUC, and corresponding tariffs approved.[36] The establishment of Small Generator Interconnection Standards [37] is designed to streamline the process for customers seeking to install net metering applications, as well as other small renewable energy generation applications.
- SEP recommends the Department of Commerce and the State Energy Office encourage and support economic development of energy-related enterprises whose products are intended to increase energy efficiency or use renewable resources, such as providers of specialized insulation and window products, heating and air conditioning equipment and controls, distributed generation equipment, solar and wind energy equipment, biofuels, and fuel cells.
- **SEO CONTRACT, The Center for Energy Research and Technology.**
- **SEO CONTRACT, Million Solar Roofs.**
- **SEO CONTRACT, North Carolina Solar Center.**
- **SEO CONTRACT, UNCA Craft Campus.**
- **SEO CONTRACT, Sustainable Community—Carrboro Collaborative.**
- **SEO CONTRACT, Sustainable Community—Town of Chapel Hill.**
- **SEO CONTRACT, SPP Brownfields to Brightfields Solar Demonstration.**
- **SEO CONTRACT North Carolina Combined Heat and Power Center.**
- **SEO CONTRACT, NC GreenPower Marketing.**

[36] See in Docket No. E-100, Sub 83.
[37] See in Docket No. E-100, Sub 101.

- **SEP Exec-8:** The General Assembly should reexamine existing legislation and regulations as pertains to barriers and strategies to develop wind energy while still protecting North Carolina's natural beauty.
- Integration with Regional Demand Response Initiatives/recommendations is a SEP recommendation.
- **SEP 4-1:** The North Carolina Utilities Commission is encouraged to promote policies that create diversity in energy supply such as natural gas, solar energy, wind energy, biomass, and hydrogen from renewable sources with particular emphasis on in-state energy development.
- **SEP 4-5:** Because the December, 2002, ice storm raised public interest in use of distributed generation i.e., in facilities used as public shelters, residential housing, etc., the State Energy Office should study distributed generation and appropriate applications.
- **SEP 5-4:** The State Energy Office, Department of Agriculture, and Department of Environment and Natural Resources should support landfill methane gas projects through direct grants and loans based on need, as well as technical assistance.
- **SEP 7-5:** State agencies should lead by example by establishing a certain minimum level of electricity to be derived from renewable sources, such as the North Carolina GreenPower Program, or via installation of state-owned renewable energy projects.
- **SEP 8-8:** The State Energy Office should provide training for building professionals on specific targeted technologies including residential daylighting, solar water heating, heat pump water heaters, new insulation products, and advanced HVAC systems and controls.
- **SEP 10-8:** North Carolina should create policies and regulations for distributed generation in the state, including incentives for deployment of "clean" distributed generation.
- **SEP 12-14:** The State Energy Office should sponsor a program to install solar equipment or other sustainable energy technologies on school buildings in every school district in the state.

Type(s) of GHG Reductions

- CO_2 reduction from avoided electricity production and avoided on-site fuel combustion less additional on-site CO_2 emissions from fuel used in CHP systems.
- Other gases: modest potential changes in emissions of CH_4 from avoided fuel combustion and avoided natural gas pipeline leakage, net of any additional on-site emissions or additional leakage from increased gas use, likely relatively small reductions in emissions of N_2O from avoided fuel combustion, net of any increased on-site emissions, and also some possible small net changes in emissions of black carbon, depending on the balance between avoided and additional consumption of oil, coal, and biomass fuels, and of emission control.

Estimated GHG Reductions and Costs (or Cost Savings)

Distributed Renewable and Clean Fossil Fuel Power Generation	2010	2020	Units
GHG Emission Savings	1.17	4.61	$MMtCO_2e$
Net Present Value (2007–2020)		$392	$ million
Cumulative Emissions Reductions (2007–2020)		33.5	$MMtCO_2e$
Cost-Effectiveness		$12	$/tCO_2e$

Data Sources: ONSITE SYCOM CHP potential estimates; NC Solar Center (for solar PV output; California "Million solar roofs" analysis for solar PV costs.

Quantification Methods: Modeled as three discrete elements:

- Solar water heating, with a target fraction of additional homes adopting solar water heaters over time and replacing a mixture of gas, electric, and LPG water heaters
- Combined heat and power, with a target fraction of North Carolina's CHP potential achieved through adoption of CHP systems fueled with gas, coal, or biomass.
- Renewable distributed generation, with a target capacity divided into residential and commercial solar PV systems and consumer-sited systems fueled with landfill gas, biomass, or biogas.

Key Assumptions: Fraction of additional North Carolina households adopting solar water heating as a result of implementation of the option. Combined heat and power generation capacity (as a fraction of North Carolina potential) achieved via RCI-10, and types of fuels used in CHP. Capacity and types of distributed renewable generation added through implementation of RCI-10.

Key Uncertainties

- Future costs of solar water heaters.
- Degree to which solar water heating targets can be attained (or exceeded).
- CHP potential in North Carolina.
- Heating fuels displaced by CHP.
- Future costs of renewable distributed generation and CHP systems.
- Types of distributed generation added.

Additional Benefits and Costs

Benefits

- Programs could help to lower capital and installation costs.
- Utility system co-benefits.
- Cost savings and decreased impacts of transmission and distribution.

Costs

None cited.

Feasibility Issues

- Cost-effectiveness dependent on price of natural gas.
- Interconnection is an issue.

Status of Group Approval

Complete.

Level of Group Support

Unanimous consent.

Barriers to Consensus

None.

RCI-11. Residential, Commercial, and Industrial Energy and Emissions Technical Assistance and Recommended Measure Implementation

Mitigation Option Description

This mitigation option includes providing residential, commercial, and industrial-sector energy technical assistance to identify options for reducing fossil energy use and reducing non-energy emissions of GHGs, along with following up on recommendations by helping to provide incentives, expertise, and information to implement recommended options.

Mitigation Option Design

It is recommended that technical assistance be provided to help identify options for energy consumers to reduce fossil energy use and to reduce non-energy emissions of GHGs, and that consumers be provided with information and incentives allowing them follow-up on that assistance to implement recommended measures. This initiative includes the following elements:

- Residential energy technical assistance for existing homes that identifies the most cost-effective energy efficiency measures, possibly including diagnostic testing of building envelopes and other home systems.
- Commercial energy technical assistance for existing commercial buildings similar to the residential services, but most likely not including diagnostic testing.
- Industrial energy technical assistance that identifies key efficiency measures, such as process heat changes, motor efficiency improvements, boiler efficiency provisions, compressed air system measures, as well as lighting and building envelope efficiency improvements. The industrial technical assistance program can identify opportunities for capture and use of process heat, as well as for implementation of combined heat and power. Opportunities for reducing the use of non-energy GHGs can also be considered.
- The technical assistance programs can include a follow-up mechanism by which those who receive services are contacted after receiving the results to answer questions and give suggestions for installing the recommended measures, and to provide access to incentives and financial assistance to encourage implementation.

Goals: Over 10,000 residential technical assistance visits, 1,500 commercial building technical assistance visits, and 300 industrial technical assistance visits can be conducted annually. Over 50% of those to whom services are provided should implement at least 50% of the recommendations. The CAPAG recommends that these goals be increased if needed to implement other RCI options.

Timing: The technical assistance program can be conducted for an initial period of 3 years beginning in 2008. Each year, an evaluation should make specific recommendations for program improvements, with a goal of increasing implementation rates. After a 3-year period, an evaluation can recommend whether to continue the program.

Parties Involved:

- Utilities: Can be involved directly in the technical assistance program, or provide funding to a separate organization.
- State Agencies: The State Energy Office has managed several similar audit programs and can fund and/or manage the effort. The Department of Environmental and Natural Resources could also manage the program. The State Construction Office could conduct technical assistance and analysis of state facilities.
- Third-party Efficiency Providers: North Carolina possesses considerable expertise in its universities, nonprofit organizations, and private consulting and technical service companies to conduct technical assistance services and follow-up tasks.
- Regulators: The Public Utilities Commission, with input from the Public Staff, can be involved in utility-sponsored technical assistance programs.
- Others: A wide variety of stakeholders can provide input into the development and continued operation of the technical assistance.

Implementation Mechanisms

Potential implementation mechanisms and supporting activities for this mitigation option include

- Participation in Voluntary Industry-Government Partnerships. For example, Climate Leaders, a USEPA program that "encourages companies to develop long-term comprehensive climate change strategies and set GHG emissions reduction goals." A state recognition and reward program can be an effective tool for emissions reduction. This can be part of the existing Environmental Stewardship Initiative (ESI).[38] "Companies participating in Climate Leaders set a corporate-wide GHG reduction goal and inventory their emissions to measure progress."[39]
- Process Changes/Optimization. Improving manufacturing so as to require less energy and/or release less GHG process gases to the atmosphere. Impacts and costs of process changes are highly process-specific.
- Leak Reduction/Capture, Recovery and Recycling of Process Gases (gases used in industrial processes). For example, solvents used in electronics industry, recovery of refrigerants, reduction of leaks in refrigeration equipment.
- Use of Alternative Gases (other HFCs, hydrocarbon coolants/refrigerants, foam blowing agents, etc.). For example, use of lower Global Warming Potential gases in specific applications, such as hydrocarbons in place of HFCs in commercial refrigeration. Some of these changes may affect energy use as well.
- Focus on Small and Medium Enterprises (SMEs). Provide resources for small and medium businesses to evaluate and pursue energy efficiency/GHG emissions reduction activities.
- Industrial ecology/by-product synergy by including full circle of industrial by-product use within other industrial processes. For example, promote review and modification of industrial processes to encourage waste reduction, and highly efficient use of materials and energy.

[38] See http://www.p2pays.org/esi
[39] See http://yosemite.epa.gov/oar/globalwarming.nsf/content/ActionsNationalPartnerships.html

- Integration with Regional Demand Response Initiatives/recommendations. This SEP recommendation might be relevant for RCI-11 in that technical assistance can be used to identify opportunities for industrial customers to participation in emergency demand reduction programs.
- Identify opportunities for water use reduction and consider the impacts of water use reduction on energy needed for, and GHG emissions due to, reduced transmission/distribution/treatment of water and wastewater.
- Focus should be on efficiency improvements that are long lived and require minimal proactive input from the customer once in place.
- Negotiated Emissions or Energy Savings Agreements. SEP recommends, for example, agreements between government and industrial or other large GHG emitters to reduce emissions on a specific time-frame.

Related Policies/Programs in Place

- There are a number of efforts in North Carolina being coordinated by Industrial Extension programs. In addition, technical assistance on pollution prevention and manufacturing efficiencies is provided by DPPEA, WRP (Waste Reduction Partners) and others (for examples, see below).
- **SEO CONTRACT, DPPEA Energy Efficiency Field Assistance Waste Reduction Partners.**
- **SEO CONTRACT, Boiler Technical Assistance Program.**
- **SEO CONTRACT, Energy Management Program.**
- **SEO CONTRACT, NC Industries of the Future.**
- **SEO CONTRACT, North Carolina Combined Heat and Power Center.**
- **SEO CONTRACT, Steam Trap Survey Program.**
- **SEO CONTRACT, ElectriCities—Energy Auditor.**
- **SEP 9-5:** The State Energy Office can develop an energy audit program for existing commercial buildings to assist building managers with implementing the most energy efficient and cost effective improvements for commercial renovation projects.
- Industrial Assessment Center at NC State University provides energy conservation and cost reduction assessments to small to medium sized enterprises.[40] This type of assistance is also currently provided by DPPEA and WRP, as well as the IES. In addition, the types of activities suggested in options 9.6 and 9.7 are also provided by DPPEA and WRP, and can be included in the demand-side management recommendation as part of RCI-1.
- Industrial Extension Services at NC State University provides surveys and audits of industrial operations to provide suggestions on cost savings from energy efficiency.[41] Waste Trader, an on-line waste exchange system, and Biomass Trader, a similar system for biomass, are joint projects between DPPEA and SEO that are relevant to this option.[42]

[40] See http://www.mae.ncsu.edu/Centers/IAC/
[41] See http://www.ies.ncsu.edu/energysurveys/
[42] See http://www.p2pays.org/

- Waste Reduction Partners (WRP) in Western North Carolina carries out technical assistance visits in the commercial/institutional and industrial sectors. The WRP program is staffed largely by volunteer retired engineers, and provides limited "energy audit" services (Terry Albrecht of WRP, personal communication).
- Greenville (NC) Utilities operates a longstanding (since 1977) residential survey/audit program, which frequently identifies savings potential for residential customers of up to 50% in overall energy use. Savings found commonly include building envelope and heating/cooling system measures, but also hot water system measures including simple plumbing fixes (personal correspondence with Andy Yakim of Greenville Utilities, 5/25/07).
- The U.S. Environmental Protection Agency offers energy efficiency audits in many states, and several audits have been performed (by local contractors) under the EPA program on buildings in North Carolina, including at North Carolina State University.

Type(s) of GHG Reductions

GHG impacts are likely similar in nature to those noted for RCI-1 through RCI-3 above, except that to the extent that voluntary emissions reduction efforts included as a part of this option target non-energy emissions, GHG impacts will vary on a case-by-case basis.

Estimated GHG Reductions and Costs (or Cost Savings)

Residential, Commercial, and Industrial Energy and Emissions Technical Assistance and Recommended Measure Implementation	2010	2020	Units
GHG Emission Savings	0.5	2.1	$MMtCO_2e$
Net Present Value (2007–2020)		–$494	$ million
Cumulative Emissions Reductions (2007–2020)		14.9	$MMtCO_2e$
Cost-Effectiveness		–$33	$/tCO_2e$

Data Sources: Adjusted costs of saved energy by sector were adapted from data in the GDS Report for the North Carolina Utilities Commission.[43]

Quantification Methods: Start with target number of technical assistance visits per sector per year, and apply estimates of fractional savings per visit (via recommended measures adopted) as a fraction of per-consumer electricity, natural gas, LPG, and oil demand. Estimate net costs of energy savings for electricity and non-electric fuels, by sector, and calculate cost difference relative to electricity and gas avoided costs, and to other fuel costs.

Key Assumptions: Actual savings achieved per customer; number of technical assistance visits per sector per year.

Key Uncertainties

- Savings achieved per customer.

[43] GDS Associates, Inc. Report for the NC Utilities Commission, *A Study of the Feasibility of Energy Efficiency as an Eligible Resource as Part of a Renewable Portfolio Standard for the State of North Carolina,* dated December 2006.

- Growth rate of customer count by sector.
- Cost of energy savings, including costs of technical assistance visits themselves (and including costs of visits that result in no consumer adoption of measures).

Additional Benefits and Costs

Benefits

None cited.

Costs

None cited.

Feasibility Issues

Impact, cost of process changes/optimization likely highly process-specific.

Status of Group Approval

Completed.

Level of Group Support

Unanimous consent.

Barriers to Consensus

None.

ANNEX A TO RCI Mitigation Option Descriptions:

Summaries of North Carolina State Energy Office (SEO) and State Energy Plan (SEP) Policies and Programs Related to RCI Mitigation Options

Note: The Summaries that follow were provided by Len Hoey of the NC State Energy Office, and are referred to when applicable in the "Related Policies/Programs in Place" sections of the Options Descriptions above.

State Energy Office Contracts and Programs

- **SEO CONTRACT, Appalachian State University Energy Center:** The North Carolina General Assembly established the Energy Policy Council in 1975 as a means of addressing state-specific energy issues and concerns. The State Energy Plan is the Council's biannual, comprehensive examination of energy use, energy production and environmental concerns in the state. As in years past, the Appalachian State University Energy Center has been contracted by the State Energy Office to prepare the State Energy Plan based on the recommendations of the Energy Policy Council, updating and revising the Plan for 2007. The Center is also responsible for assisting the State Energy Office in implementing the recommendations of the State Energy Plan. As part of its implementation duties, Appalachian State University performs the following tasks, among others:
  - Provides data on the potential for energy efficiency in various customer segments, preparing a final analysis and report for submission to the State Energy Office and Energy Policy Council.
  - Coordinates the North Carolina Fuel Cell Alliance to further expand the fuel cell industry in the state.
  - Updates economic analysis of standard and renewable electricity technologies due to changes in fuel costs, including projections of renewable electricity potential.
  - Works with the North Carolina Economic Development Board in creating a strategy that informs the state's businesses and government leaders on the potential of renewable energy industries as part of the state's technology-based economic development strategy.
  - Works with officials at several North Carolina landfills to conduct technical and economic analysis of landfill energy production for fuel and electricity generation.
  - Provides input into statewide transportation policy and planning by developing a design for modular biodiesel plants; working with area farmers on production of crops for conversion to biofuels; working with other state transportation efficiency efforts to reduce dependence on petroleum-based transportation; and providing

technical support to statewide agencies and universities to displace 20 percent petroleum use in state vehicles.

- Provides commercial building efficiency outreach by working with State Construction Office officials to develop new energy standards for State buildings and an evaluation and monitoring system to assure the use of these standards.
- Promotes high performance homes by conducting sessions for production builders on new ENERGY STAR® homes; conducting a North Carolina-based ENERGY STAR conference; developing new home designs based on input from affordable housing groups; and conducting workshops on the Zero Energy Home concept and design.
- Furthers energy education by holding meetings with school officials about building energy use, energy-related curricula and energy demonstration projects.
- Furthers renewable energy initiatives in the western part of the state by purchasing and loaning an anemometer tower to assess wind development sites; providing consultation services for wind assessments; conducting workshops on residential- or farm-scale wind energy; and developing ordinances and working with local officials regarding wind turbine permitting.

- **SEO CONTRACT, Energy Management Program:** This program, operated in conjunction with the North Carolina State University Industrial Extension Service, provides workshops and industrial energy surveys that identify opportunities and demonstrate techniques for optimizing energy use in various building systems and promoting energy conservation in industrial, institutional, commercial and governmental buildings. Industrial surveys provide comprehensive audits of common system inefficiencies (such as leaky compressed air systems, poorly-adjusted steam traps, etc.) and provide recommendations for energy improvements. The tasks involved in this project include performance of energy surveys, development of energy-saving recommendations, technical assistance, development, implementation and promotion of workshops and educational materials.
- **SEO CONTRACT, The Center for Energy Research and Technology:** The Center for Energy Research and Technology, housed at North Carolina A&T State University, provides education, training, demonstration and technical assistance on energy and environmental technologies. Programs fall under three main areas: technical transfer (outreach), demonstration and the manufactured housing research initiative. Recent projects have included the installation and monitoring of a photovoltaic system installed on residential buildings; collection and analysis of survey data on customer complaints of manufactured homes; a demonstration energy efficient manufactured home; industrial workshops on HVAC operation and indoor air quality; summer "energy camp" programs to introduce secondary school children to various energy systems and encourage their entrance into the energy field; and assessment of wood residues in the state available for energy production.
- **SEO CONTRACT, Energy Efficiency for Nonprofits:** The Nonprofit Energy Efficiency Program works with small- to medium-size private and public nonprofit agencies, including local governments and schools, to install low-cost energy efficiency

measures that will reduce operating expenses. Where possible, volunteers from the nonprofit organization are trained to install the measures under supervision of trained contractors, utility personnel and staff from the State Energy Office and collaborating groups. Emphasis will be placed on measures that have a ten-year or better payback. Energy bills for a selected sample of organizations will be monitored for at least one year following installation to determine actual energy costs savings. A match of $100,000 was provided by Piedmont Natural Gas for this program.

- **SEO CONTRACT, ElectriCities—Energy Auditor:** Energy audits, once a common utility service for residential customers, are now rare offerings. The state's three major utilities do not offer them, and only a handful of municipal and electric cooperatives offer them. The savings potential from a home energy audit is enormous, however, particularly in light of the rapidly increasing costs of today's utility bills. ElectriCities of North Carolina, Inc., with support from the State Energy Office, will maintain a two-year program for a circuit riding energy auditor to provide energy audit services to residential customers of municipal electric distribution systems in northeastern North Carolina. The goal of the project is to conduct 1,000 on-site energy audits and to offer 100 energy education workshops with estimated attendance of 1,000 people over the project's two-year span. In addition, the project will make a Web-based energy audit service available to all ElectriCities residential customers, enabling many more additional audits to be conducted. Savings to consumers will vary, though an average of 15 percent for residential energy costs, or nearly $300 per household, is a safe assumption. Environmental benefits, based on reduced energy use, will be significant.
- **SEO CONTRACT, Energy Efficiency Field Assistance Waste Reduction Partners:** Waste Reduction Partners is a team of 51 volunteer and retired engineers, scientists and architects that provides waste reduction and energy efficiency assistance to businesses, industries and public facilities in the state's 37 western-most counties. With support from the State Energy Office, Waste Reduction Partners is serving a critical community need by responding to requests for on-site energy-efficiency technical assistance, strategic energy management planning, and implementation facilitation for western North Carolina industries, businesses and public facilities, including primary and secondary public schools, local governments and state agencies. This assistance is free and supports the objectives of the State Energy Plan and the State Energy Office's Utility Savings Initiative.
- **SEO CONTRACT, Central and Eastern Waste Reduction Partners:** This initiative will create a Waste Reduction Partners technical outreach program to assist central and eastern North Carolina businesses and institutions in becoming more energy efficient, economically competitive and environmentally sustainable. This project expands on the successful western North Carolina Waste Reduction Partners program of the Land-of-Sky Regional Council of Governments in Asheville, which utilizes the technical expertise of 51 retired volunteer engineers and scientists working in conjunction with program staff.
- **SEO CONTRACT PEM Fuel Cell:** In order to showcase the beneficial uses of PEM fuel cells, the North Carolina Solar Center at North Carolina State University is building a fuel cell demonstration model that will provide supplemental power to the Center's new alternative fuel vehicle garage. Specifically, the operational system will consist of a

commercial electrolysis unit powered by photovoltaic panels on the roof of the garage, a low pressure hydrogen storage tank, a commercial PEM fuel cell, and an inverter to convert the fuel cell output to 120 VAC. A benchtop demonstration model featuring see-through, micro-power versions of the main operational system components will further educate the public about the benefits of PEM fuel cells and hydrogen power. The demonstration model will benefit from existing outreach activities of the Center's North Carolina State University Solar House, which has welcomed over 250,000 visitors since it opened in 1981.

- **SEO CONTRACT Landfill Gas Conference:** The objective of the Landfill Gas and Combined Heat and Power: Technologies and Opportunities Conference was to further develop distributed energy projects that utilize landfill gas fuel around the southeastern United States. The North Carolina Solar Center acted as the lead agency, with State Energy Office support, in organizing three of these short conferences to examine landfill gas energy production technologies and to share success stories within the region. The conferences also spotlighted common and potential hurdles to implementing a landfill gas system in a community and how to overcome these hurdles.
- **SEO CONTRACT Energy Management Diploma:** The Energy Management Diploma Program is a fourteen-day course over approximately six months that trains state, local government, nonprofit, university and community college officials in the development and implementation of effective energy management programs. Upon the successful completion of the course and a written exam, students receive a Diploma in Energy Management from North Carolina State University.
- **SEO CONTRACT Consumer Energy Education Program:** The Consumer Energy Education Program, also known as E-Conservation, was created to inform and educate North Carolina consumers about ways to both reduce energy use and increase energy efficiency in the home. Most North Carolina utility companies have eliminated or significantly reduced their consumer energy awareness and education programs. This project is designed to help consumers reduce home energy consumption and assist them in saving money through no-and low-cost energy efficiency measures, behavioral changes and home retrofits. Trained county extension agents offer consumer education workshops, conduct home energy audits, distribute consumer energy kits with information on energy conservation and efficiency, participate in community events, and develop partnerships with other energy professionals. The agents provide ongoing evaluations to determine the effectiveness of the E-Conservation energy education program.
- **SEO CONTRACT Building Operator Certification:** This project will promote energy conservation in state and local government, institutional, commercial and industrial buildings throughout the state. This will be accomplished by introducing the Building Operator Certification Program to North Carolina through community-college based training courses. The program will provide training in energy-saving building operating practices and in identification and implementation of energy-conservation projects for building operators (e.g. school facilities staff).

- **SEO CONTRACT National Energy Education Development:** The National Energy Education Development Program is dedicated to implementing comprehensive energy education programs in the nation's schools. This will be accomplished by creating effective networks of education, business, government and community leaders to design and deliver objective, multilateral energy education programs. In North Carolina, the project will train 200 teachers and reach 9,000 students directly.
- **SEO CONTRACT, Sustainable Design Competition:** The NC Sustainable Building Design Program aims to integrate the foundations and principles of sustainable design into college-level curriculums. The main event in this program is the annual Sustainable Building Design Competition. Through this competition, students create a residential structure that is later built and used as a model "sustainable" house. Student teams are from diverse curriculums and are encouraged to create multi-institutional and cross-curriculum teams. Students enter the workforce experienced in and knowledgeable about energy efficient, sustainable design. The program, now in its sixth year, has involved over 1,200 students, professors and professionals and 10 North Carolina community colleges and universities. Support from the State Energy Office will help ensure the expansion of the current program to include more mainstream sustainable design options through demonstration projects and more participating schools. It is the vision of the competition organizers to recruit five additional schools per year totaling 20 schools by the 2008 academic year. This would impact approximately 2,000 students, professors and professionals by 2008.
- **SEO CONTRACT, RFP for Utility Accounting Services:** The purpose of this program is to provide utility data input and collection for state agencies, the University of North Carolina system, community colleges, primary and secondary public schools and local governments. This is not a contract as each individual participant will create their own purchase order referencing this RFP.
- **SEO CONTRACT, State Energy Office Information and Referral Center:** The State Energy Office information and referral center manager will create and manage an on-site and virtual information center. Duties will include acquiring, organizing and disseminating information through the State Energy Office Web site, exhibitions, workshops, conferences, media events, mailings, on-site visits, telephone calls and other activities. This position will be the initial contact for public inquiries and two-way communication about energy information. This position will be responsible for both online and print material selection, printing contracts and publication development and distribution. Additionally, this position will be responsible for developing promotional strategies for State Energy Office information services and collecting and organizing Information and Referral Center statistics.
- **SEO CONTRACT, Heat Pumps in Manufactured Homes:** Historically, nearly one-third of the new homes sited annually in North Carolina are manufactured homes (formerly referred to as mobile homes). Many consumers choose manufactured homes because they offer a more affordable housing option for their families. The benefits of a lower monthly mortgage payment are often negated by the additional monthly operating expenses of an electric-resistance furnace, however. In some instances, the monthly winter utility payment may actually be higher than the monthly mortgage payment. The

approximate cost of upgrading a manufactured home from the standard forced-air, electric-resistance furnace with central air conditioning to an energy-efficient heat pump (to provide both heating and cooling) is about $400 per home. Homeowners who upgrade to an energy-efficient heat pump can expect to save $375 to $750 per winter heating season in energy costs. With the support of the State Energy Office, the Eastern Carolina University College of Technology and Computer Science developed an "upgrade and save" program that has secured the participation of 37 manufactured home retailers in 17 eastern North Carolina counties. The program reimburses both retailers and existing manufactured homeowners for the approximate cost to upgrade to an energy-efficient heat pump. Around 130 homes have received upgrades to date. The next phase of the program is detailed below.

- **SEO CONTRACT, NC GreenPower Marketing:** North Carolina GreenPower is a statewide program designed to improve the quality of the environment through development of renewable energy resources using consumers' voluntary purchase of green power through electric utilities in North Carolina. The program revenues provide financial incentives for generators of electricity from renewable sources. The four main objectives of the program are to improve the quality of the environment; increase the amount of generation from renewable and alternative energy sources; maximize the amount of investment in renewable generation; and maximize the number of participants in the program. The objective of the marketing and outreach project is to expand the statewide advertising, communications and education campaign to promote the use and development of renewable energy generated in North Carolina. Particular emphasis is placed on increasing corporate sales activities, through which the program most effectively and more readily can reach its participation goals.
- **SEO CONTRACT, Million Solar Roofs:** The Million Solar Roofs Partnership, administered by the North Carolina Solar Center at North Carolina State University, helps supports local organizations in eight locations around the state in continuing educational outreach and advocacy projects supporting solar technology deployment. Examples of local projects include educational forums, solar home tours, technology demonstrations, technology workshops, local policy support, tracking local solar installations, and support for North Carolina GreenPower, an independent, nonprofit organization established to improve North Carolina's environment through voluntary contributions toward renewable energy. The partnerships are in Asheville, Charlotte, Fayetteville, Wilmington, Chapel Hill, and the counties of Guilford, Durham and Watauga.
- **SEO CONTRACT, North Carolina Solar Center:** Created in 1988, the North Carolina Solar Center serves as a clearinghouse for renewable energy programs, information, research, technical assistance, and training for professionals and consumers in North Carolina. The Solar Center is operated by the College of Engineering at North Carolina State University. The activities and initiatives funded by this program will move North Carolina closer to a sustainable energy future through technology transfer programs, extensive workforce development programs, and efforts to educate the public and shape government policy. The Center has served as the lead agent of the State Energy Office for nearly two decades in the area of active and passive solar energy, and has in recent years

assumed a leadership role in a broader array of renewable power and industrial efficiency technologies, high performance building systems and alternative transportation fuels and technologies.

- **SEO CONTRACT, UNCA Craft Campus:** The University of North Carolina at Asheville is building a new Craft Campus close to their main campus and downtown Asheville. In addition to providing a central location to display the work of western North Carolina and UNC-Asheville artists, the Craft Campus will serve as a demonstration site to showcase and teach the public about a variety of renewable energy technologies. The campus design team has developed a cohesive, systematic view focusing on green building principles that integrate studio needs, public spaces and on-site energy sources including landfill gas, wind, water and solar power. This will be the only site in North Carolina comprehensively demonstrating the renewable energy and energy efficiency technologies that could impact our lives in the near future.
- **SEO CONTRACT, Sustainable Community—Carrboro Collaborative:** This demonstration project is intended to provide solar-assisted hot water and photovoltaic lighting for the "common house" in the Pacifica neighborhood located in Carrboro, N.C. This highly visible project will be located in a sustainable Orange County subdivision that consists of 46 energy efficient low- to moderate-income homes. The homes in the Pacifica neighborhood will provide this project with a complimentary demonstration of high performance homes. Forty-two of the 46 homes have a passive solar design, 16 have solar hot water systems, 11 have whole house instantaneous hot water systems and 19 have hot water-heated radiant floors. It is projected that local, regional and statewide builders, developers and potential new home purchasers will tour the site to learn about the advantages of solar water heating and photovoltaic lighting. Recent emphasis on alternative, sustainable energy sources coupled with the current increase in fuel costs will help to raise consumer awareness of this sustainable option.
- **SEO CONTRACT, Sustainable Community—Town of Chapel Hill:** The purpose of this project is to provide funding for the purchase and installation of a photovoltaic system at the Town of Chapel Hill's Fire Station Number 1.This upgrade will be an extension of an earlier sustainable community grant, which the town utilized to successfully complete an energy audit and several efficiency upgrades, including installing energy efficient doors and windows, upgrading the efficiency of the HVAC units, replacing inefficient appliances with ENERGY STAR®-rated appliances and purchasing two solar exterior lights.
- **SEO CONTRACT, SPP Brownfields to Brightfields Solar Demonstration:** "Brightfield" is a term that was coined by the US Department of Energy to describe redevelopment projects that incorporate renewable energy or distributed energy generation systems into the redevelopment of "Brownfields," or industrial and commercial facilities where expansion or redevelopment is complicated by real or perceived environmental contamination. Such was the case of Lot 86 on the North Carolina State University campus in Raleigh where, during the 1970s and 1980s, the site was used as an agricultural pesticide dump. Carolina Green Energy, formed in 2004 to build renewable energy generation in North Carolina, will build, own and operate a 35 kW photovoltaic power generation project on Lot 86. The electricity generated will be

sold to Progress Energy under an avoided cost contract and the renewable energy certificates will be sold to North Carolina GreenPower under a separate contract. North Carolina GreenPower is the first statewide green energy program in the nation supported by all the state's utilities and administered by a nonprofit corporation. The goal of North Carolina GreenPower is to supplement the state's existing power supply with more green energy, or electricity generated from renewable resources such as the sun, wind and organic matter. All proceeds from this project's electricity sales and green power certificates will be used to cover operational costs, maintenance costs and equipment financing charges.

- **SEO CONTRACT North Carolina Combined Heat and Power Center:** Combined heat and power technologies offer many benefits to society. Conventional means of generating electricity typically convert 33 percent or less of the energy available in a fuel source into useful energy for consumers; the other 66 percent of the energy potential is discarded as waste heat. A regional combined heat and power center can help situate power generation technologies near locations that require a heat source. The "waste heat" from generating electricity can be used to satisfy heating requirements. Various technologies can even allow the "waste heat" to be converted so that cooling and dehumidification needs can be met. This project will continue support for the North Carolina Combined Heat and Power Application Center to promote combined heat and power applications throughout the state. This will be accomplished by continuing assessments of potential sites at public and private facilities that could host combined heat and power, assisting in the development of demonstration sites, supporting a broader market acceptance of combined heat and power concepts and technologies, and providing regular monthly status reports tracking progress of the program.
- **SEO CONTRACT, DPPEA Energy Efficiency Field Assistance Waste Reduction Partners:** Waste Reduction Partners is a team of 51 volunteer and retired engineers, scientists and architects that provides waste reduction and energy efficiency assistance to businesses, industries and public facilities in the state's 37 western-most counties. With support from the State Energy Office, Waste Reduction Partners is serving a critical community need by responding to requests for on-site energy-efficiency technical assistance, strategic energy management planning, and implementation facilitation for western North Carolina industries, businesses and public facilities, including primary and secondary public schools, local governments and state agencies. This assistance is free and supports the objectives of the State Energy Plan and the State Energy Office's Utility Savings Initiative.
- **SEO CONTRACT, Boiler Technical Assistance Program:** The Boiler Technical Assistance Program helps state-operated and industrial, commercial and institutional facilities measure and improve boiler efficiency and implement boiler-related energy conservation measures. This is accomplished through statewide workshop presentations and on-site boiler surveys. The workshops teach participants how to confront their boiler problems, work through solutions and return to their jobs with the tools to solve their own in-plant problems. The on-site boiler surveys offer boiler system evaluations and technical assistance to those institutions that attend one of the workshops. Potential

beneficiaries include industry engineers, systems operators and boiler operating personnel from schools, hospitals, state government agencies and universities.

- **SEO CONTRACT, NC Industries of the Future:** The North Carolina Industries of the Future program will assist North Carolina industry in implementing innovative energy efficiency methods to become more globally competitive. Industrial sector businesses that are large energy users will be targeted for this program, with a focus on the five originally-designated North Carolina Industry of the Future sectors of glass, agriculture, forest products, chemicals and mining. Best practices training workshops will be provided for each of the industry sectors, and assessments for 12 energy-intensive facilities will be distributed among the sectors and other large energy users. Reports on program progress will be presented for the stakeholders to self-assess the progress and effectiveness of the program and to redirect efforts if necessary in order to achieve success.
- **SEO CONTRACT, Steam Trap Survey Program:** The purpose of this program is to provide steam trap survey services to a variety of North Carolina industrial facilities, commercial businesses, local government and institutional facilities using steam for heating and/or processing. Steam traps are identified, tested and tagged if not working properly. These services enable facilities to cut steam loss, thereby saving energy and money. Program participants receive a fixed amount of funding for each steam trap surveyed. The surveys are conducted by approved firms.

State Energy Plan Policies and Programs

- **SEP Exec-1:** The North Carolina Department of Commerce and the State Energy Office should encourage and support economic development of energy-related enterprises whose products are intended to increase energy efficiency or use renewable resources, such as providers of specialized insulation and window products, heating and air conditioning equipment and controls, distributed generation equipment, renewable energy equipment, biofuels, and fuel cells. ASU Energy Center has developed info on energy-related jobs and economic impact and has met with industry and economic development leaders to discuss how to bring more energy-related business and jobs to NC. Summary information has been presented to economic developers in four of the seven NC economic development regions to date in 2004. A handbook on renewable energy data available in the database is under development. The NC Solar Center staff provided financial incentives consultation to Carolina Green Energy to support potential development of a coastal NC wind farm. The NC Solar Center and SEO partnership provides services that support companies that produce and/or install renewable energy technologies. A directory of professionals offering services in various categories of renewable technology is available to the public. And, the NCSC offers design reviews, for both residential and commercial developments, that detail energy savings opportunities and encourage use of renewable design features. The NCSC supports the development of renewable energy through training for contractors, trades people, designers, and others on a range of topics that include solar electricity, solar heating, sustainable design, and day lighting.

- The Million Solar Roofs program, coordinated through the NC Solar Center, has established 7 partnerships around the state. Partnerships have developed strategic plans that highlight steps to encourage the use of solar technology. A small grants program supports solar technology demonstration projects in local partnerships areas. Hosted by SEO and DENR, an interagency landfill gas steering committee has been meeting to discuss issues and opportunities related to converting landfill gas to energy. The group also has participation from Commerce, NC Solar Center, NC GreenPower, EPA's LMOP, landfill gas developers, and the Carolinas Solid Waste Association. Major issues revolve around regulatory, administrative, and industry proximity. The group sponsored a NC landfill gas conference on December 10, 2004, at the McKimmon Center. As part of this conference, a GIS mapping effort by NC OneMap showcased the proximity of 131 LMOP landfills to potential LFG users. A landfill gas focus group has met to discuss and identify the barriers to LFG development. These barriers are expected to be discussed with the PUC staff to attempt to resolve the issues. Landfill gas development studies are be conducted for sites owned by Buncombe County, Robeson County, City of Durham, and 20 other sites identified as top prospects for development. The Schools Going Solar project, coordinated through The NEED Project, allows schools to receive photovoltaic installations and solar energy curriculum and training programs in order to facilitate both an understanding of the impact of solar energy and its diverse applications. The NC Schools Going Solar Project will install a total of six systems with the majority of them being placed in Million Solar Roof communities. The NEED Project anticipates installation at all six schools by the end of October 2005. (Move to USI?)Continue to investigate cost-effective solutions for National Guard 25 kW power backup application. Prepare and present power point presentation on hydrogen fuel cells for power backup applications during USI Steering Committee meeting on August, 24th. Meet with Hydrogen Economy Advancement Team, to review RDU airport presentation briefing on August 12th (DENR). Meet with "Fuel Cell Roadmap Team" on August 16th, Chapel Hill. NC A&T State University purchased and installed a PEM Fuel Cell on campus as a demonstration in April 2005. The performance of the fuel cell application will be studied and recommendations made in terms of widespread use of fuel cells. The NC GreenPower program now has over 7,000 participants who are supporting the purchase of almost 17,000 blocks of 100 kWh. This amounts to approximately 20 million kWh annually of greenpower purchases. The program has 11 small PV providers, a 35 kW project planned, 2 landfill operations and a swine waste generator as part of the mass market program. The large volume product has a small hydro aggregation generator, a portion of the Craven Wood Waste output, and a swine waste plant as part of the program. SEO supports the marketing and outreach portion of NC GreenPower as do the utilities and Advanced Energy.
- **SEP Exec-7:** The General Assembly should evaluate a renewable portfolio standard (RPS) that complements the NC GreenPower program and fosters the development of a renewable electricity market. The RPS would require that all electric utilities increase the percentage of total distributed electricity that comes from renewable sources, such as hydroelectric, wind, solar, waste-derived fuels, and agricultural fuels.
- **SEP Exec-8:** The General Assembly should reexamine existing legislation and regulations as pertains to barriers and strategies to develop wind energy while still

protecting North Carolina's natural beauty. With SEO and DOE support, a statewide map showing wind development potential has been developed. A mountain wind attitudes study has been completed, showing strong support for wind among local residents. Scenic view protection must be incorporated into wind turbine location. An environmental analysis is being conducted to determine endangered species of plants and animals that could be impacted by wind power development. ASU completed a coastal wind attitudes survey and prepared a report to the Coastal Wind Working Group. Coastal residents also showed support for area wind development although respondents did note concern for placement of wind turbines in national forests and in sounds. A Small Wind Demonstration Center has been established at Beech Mountain, NC. The center currently has 6 wind turbines installed and these are generating electricity for sale to Mountain Electric Coop. A website for information about the project is at http://www.wind.appstate.edu/swiwind/swi.php. NC Coastal Wind Assessment and Coastal Wind Working Group continue to address regulatory, financial, and environment issues. In addition, a coastal anemometer program has sited 6 anemometers to collect wind data. Additional information is at http://www.ncsc.ncsu.edu/programs/The_Coastal_Wind_Initiative.cfm.

- **SEP Exec-9:** The State Energy Office should assess and propose incentives and regulatory or administrative measures for development of renewable electricity generation facilities, solar water heating, passive and active solar space heating, and daylighting. SEO is co-sponsoring, funding, and actively participating in the NC GreenPower Program. The program is currently averaging 20M kWh annually in contributions and should result in significant expansion of renewable electricity generation in NC. Clean Technology Demonstration RFP contracts have been awarded to the following: Appalachian State University (NC Small Wind Initiative), the NEED Project (solar panels in schools), Wake Technical Community College (E85 Infrastructure), and Central Carolina Community College (Biofuels from Cooking Waste). ASU Energy Center has conducted research on potential savings associated with widespread adoption of residential solar water heating systems tied to new construction. This included telephone interviews with solar dealers in NC and national manufacturers. Discussions are underway with several residential developers interested in installing solar water heating systems in new homes. A NC Daylighting Consortium has been established through the NC Solar Center. This consortium has the following goals: identifying and evaluating daylighting resources; adopting standard evaluation protocol; and facilitating the inclusion of daylighting technologies in professional practice to improve building performance in an environmentally sustainable manner. NC HealthyBuilt Homes (HBH), a green builder program, has been developed and promoted to builders. This program offers builders marketing incentives and access to information that supports renewable technologies. Visit the following website for current information: http://www.ncsc.ncsu.edu/programs/North_Carolina_HealthyBuilt_Homes_Program.cfm. The HBH program now has 27 builders statewide and 55 homes that are underway. 7 homes have been completed under the program. The HBH is targeted to small and medium sized builders. The first project that used NC HealthyBuilt Homes exclusively has been completed by Mountain Housing Opportunities, Inc. in Asheville. The 15-units in this low-income, green housing development were all certified as HealthyBuilt Homes.

Sustainable building concepts and products, such as passive solar design, solar water heating and environmentally-friendly products, were featured in this "Green Building Demonstration" project. Under the Sustainable Community Development RFP, the SEO has issued contracts to Carrboro Collective, Blue Ridge Resource Conservation & Development Council, Altamont Environmental, and Town of Chapel Hill for projects with renewable energy elements. The "Guide to Interconnection of Small PV Systems for NC GreenPower" was published. This guide describes steps necessary for interconnection and notes required forms and documents.

- **SEP Exec-10:** The General Assembly should require that all electric utilities in North Carolina provide generation disclosure of fuel mix percentages and emissions statistics on sulfur dioxide, nitrogen oxides, carbon dioxide, and mercury annually by bill insert and via website. The disclosure information should clarify to the consumer the environmental impact of residential electricity use. The NC GreenPower Program must clarify the extent to which disclosure of fuel mix and emissions is required to maintain the Center for Resource Solutions' national certification as a valid green product. The ASU Energy Center has prepared a disclosure briefing paper with recommendations for legislation requiring suppliers of electricity to report semi-annually, via bill insert, on respective mix of fuels and emissions.

- **SEP Exec-11:** State agencies and universities, with coordination by the North Carolina Department of Administration, should reduce energy consumption in existing state buildings to save 20% by 2008, 4% per year or more for the next 5 years. The State Energy Office should submit an annual report to the Energy Policy Council, the Governor's Office, the State University System and other major energy users in North Carolina that provides data on energy saved in state buildings and universities by source and cost, energy efficiency activities undertaken in these buildings, the approximate investment in energy efficiency measures, and the overall economic costs and benefits of the program. The program is centered on a goal of reducing energy consumption in state agencies by 20% over a five-year period ending in 2008. Since the program's inception, the Utility Savings Initiative while spending $2,347,599 (since 2003) has saved the State of North Carolina more than 2,135,260 MMBTU, with $33 million in avoided costs. The program recently has been expanded to the state's community colleges and will be provided to local governments and public school systems in the near future. The program uses a four-pronged approach to achieve its goal; utility accounting, operations and maintenance, awareness and training and performance contracting. For tracking purposes, energy consumption is indexed by gross square feet to accommodate growth in state facilities.

- **SEP Exec-13:** North Carolina should facilitate efforts of local governments to finance energy efficiency and renewable energy projects; specifically, allow bundling of multi-jurisdictional energy efficiency projects to achieve economies of scale and improve opportunities for financing, restructure the underwriting provisions of the State Energy Office's low-interest energy loan program, and provide training in energy efficiency measures to building managers in local government buildings. SEO and DPI co-sponsored training for the state's 117 school districts that will result in preparation of local strategic energy plans for K-12 schools. The Department of Public Instruction sent

51 persons, representing 40 school systems, to three regional SEP workshops in May, 2004. An additional workshop was held in December 2004 for 45 attendees, representing 30 school systems. SEO sponsored four energy efficiency and sustainability workshops for administrators and facility directors of K-12 schools. The workshops for school officials were organized by NEED and DOE's Energy Smart Schools Program. The SEO assisted in planning for the SEQL (Sustainable Environment for Quality of Life) program for local governments in the Charlotte Metro region. Local governments (county, municipal, K-12) were invited and attended SEO performance contracting training. Local governments are encouraged to use the SEO list of qualified energy service companies, RFP template, and other sample documents for performance contracting. Site visits and technical analysis by SEO staff are available to local governments also.

Training in energy efficiency measures under USI is available to local governments. The 2004 Energy Management Diploma class includes several community college, K-12, county and city government energy managers. A contract with Waste Reduction Partners provides local government energy audits in western NC, investigates financing options for energy projects, and offers follow-up technical assistance for strategic planning and implementation. Permanent rules have been approved by the Rules Review Commission for both performance contracting in State-Owned Buildings and for the Energy Improvement Loan Program. The approved Rules will be available on the SEO website in September for performance contracting and in October for the loan program. A standard RFP and an Investment Grade Audit (IGA) template have been reviewed by the Attorney General's Office. A standard Energy Services Agreement is presently being reviewed by AG's Office. Performance Contracting Training for Public Housing Authority staff is scheduled for October 28-29, 2005, in Raleigh. Performance Contracting Training for Community Colleges was held November 10, 2004, in Enka, NC. Requests for Proposals for Performance Contracting have been evaluated for the Museum of Art, UNC-Greensboro, and the downtown chiller loop which will include more than 10 buildings in the downtown government complex. The Department of Correction has issued an RFP for performance contracting at Nash, Harnett, and Women's prisons. SEO has provided performance contracting assistance to Scotland, Yancey, and Alleghany Counties and to Durham Tech. The DOA Legal Counsel has approved all documents related to the Energy Improvement Loan Program. The first Energy Improvement Loan Program document package was completed and mailed to Franklin Health and Fitness for signature. Once all documents are signed by DOA and the client, they will be the first executed loan since the expansion of the Loan Program to include local government and non-profits.

- **SEP Exec-14:** The State Energy Office should develop programs, in addition to weatherization, to address energy-efficient housing in the low-income sector. The State Energy Office should investigate technologies, incentives, financing options, and regulatory issues regarding minimum efficiency requirements for manufactured housing and promote ENERGY STAR manufactured homes.

  The SEO formed the Low Income Residential Energy Program (LIREP), initially focusing on new construction in manufactured homes (MH) and with public housing authorities. The original target audience of Greenville Utilities service area customers

included Greenville and approximately 80% of Pitt County. Subsidy money (up to $500/home) will be paid to the local MH retailers who equip the customer's new homes with high-efficiency heat-pumps as the primary heating system instead of electric-resistance furnaces. This contract has been completed. LIREP's Upgrade & Save Program, operated by East Carolina University, has been expanded to include MH retailers and potential new home buyers in Pitt and sixteen surrounding counties of Beaufort, Bertie, Carteret, Craven, Duplin, Edgecombe, Greene, Halifax, Jones, Lenoir, Martin, Nash, Onslow, Pamlico, Wilson &.Wayne. Subsidies are paid to the MH retailers who sell heat pump-upgraded homes. The program has active involvement from 37 MH retailers and HVAC distributors/suppliers in the local areas. The program offers "retrofit" assistance (50% of the cost, up to $1,500) to area MH owners who purchased homes manufactured since 1/1/1998 and before 1/1/2004. Through June, 2005, over 100 manufactured homes have been upgraded to heat pumps. We are working with ECU to expand "Upgrade & Save" to additional eastern NC counties next year. The SEO is partnering with the National Association of Energy Service Companies in a DOE Special Project contract to work closely with three North Carolina PHAs to use performance contracting to finance energy efficiency measures in existing PHA units. This process will save energy when renovating aging housing and equipment. The project provides training, development of a template RFP, and technical assistance from the SEO. SEO is working with Advanced Energy to ensure energy efficient construction in several PHA projects. The new units will be built to high efficiency levels so that residents are offered guaranteed low monthly utility bills. Two prospective locations have not moved forward due to holdup of HUD Section 8 funding and permitting concerns. Five other locations are in negotiation. SEO's LIREP project with Mountain Housing Opportunities in Asheville is complete. The 15-unit development, which consists of single family and multi-family structures, utilizes energy-efficient sustainable construction. High efficiency heat pumps and solar water heating were incorporated in the revitalization of this existing community. All structures conformed to the NC Solar Center's HealthyBuilt Home standards. Total annual energy savings of 60,760 kWh or $5,165 are anticipated. Water use reduction measures are expected to save 74,000 gallons annually. Annual pollution reductions of 84,856 lbs. in CO_2, 4,557 lbs. in SO_2 and 369 lbs. in NO_x are expected.

A LIREP contract with Metropolitan Housing & Community Development Corporation in Washington, NC, for 36 low income energy-efficient homes, has been approved. Construction on the units has begun. An RFP to solicit potential projects for the remaining funding under the Low Income Residential Energy Program will be issued in 2006. The "Renewable Energy Project in New Affordable Homes in Western North Carolina", conducted by Appalachian State University, is near completion. This project is intended to increase the use of renewable energy technologies in residential construction, especially in affordable housing. A passive solar home plan books for affordable housing is complete. The project provided design/installation assistance for construction of a Zero Energy Home (ZEH). The ZEH, built by the local Habitat for Humanity chapter in Hickory, is completed. It features a ground-source heat pump, photovoltaic panels, passive solar design and solar water heating. The new Consumer Energy Education program was launched with N.C.S.U.'s Cooperative Extension Service. Under this program, 3 pilot counties (Buncombe, Orange, Edgecombe) will present consumer and

extension agent training and schedule 100 energy audits for consumers to educate homeowners about energy efficiency and ways to save money and energy. Three workshops have been scheduled; bids from energy auditors have been received and the program manager, to be based at NCSU has been recommended for hire. Southface-North Carolina Office, under an SEO Special Projects contract, developed informational placards to be placed in high performance homes, including high performance homes for the low income sector. The placards address topics including: improved insulation; air sealing; duct sealing; low-e windows; compact fluorescent lamps; appliances; balanced ventilation; and ENERGY STAR Homes.

- **SEP Exec-20:** The State Energy Office should organize a statewide effort to develop criteria for a residential high performance building program to reduce the life cycle cost of new and existing buildings. The criteria should utilize provisions from other successful high performance programs, including ENERGY STAR, programs developed by Advanced Energy Corporation, NC Healthy Built Homes, Southface Energy Institute's Earthcraft Home Program, US Department of Energy's Building America program, and others. As a result of our residential energy-efficiency "umbrella" promotion initiative, SEO and ASU has launched an NC ENERGY STAR Website; http://www.ncenergystar.org. Through collaboration with representatives of utilities and other organizations who market energy-efficiency housing programs across the state, the SEO will promote all of the current residential energy-efficient programs which meet or exceed the ENERGY STAR standards. An ENERGY STAR Conference is scheduled for December, 2005. A contract, with the Residential Energy Services Network (RESNET), that is intended to promote energy efficient construction and energy efficient mortgages in NC is in the DOA approval process. RESNET will partner with Wachovia Mortgage, Countrywide Home Loans and Fannie Mae to deliver this project.
- **SEP Exec-15:** The General Assembly should review options, such as a Public Benefits Fund (PBF) or other means, to enable funding of the recommendations in the State Energy Plan. A report was prepared by ASU Energy Center on evolution of PBFs in other states and presented to the Council 11/20/03. ASU developed a PBF economic analysis model with input from several economists. An evaluation by NREL will be presented to the Council on 3/31/05.
- **SEP Exec-20:** The State Energy Office should organize a statewide effort to develop criteria for a residential high performance building program to reduce the life cycle cost of new and existing buildings. The criteria should utilize provisions from other successful high performance programs, including ENERGY STAR, programs developed by Advanced Energy Corporation, NC Healthy Built Homes, Southface Energy Institute's Earthcraft Home Program, US Department of Energy's Building America program, and others. As a result of our residential energy-efficiency "umbrella" promotion initiative, SEO and ASU has launched an NC ENERGY STAR Website; http://www.ncenergystar.org. Through collaboration with representatives of utilities and other organizations who market energy-efficiency housing programs across the state, the SEO will promote all of the current residential energy-efficient programs which meet or exceed the ENERGY STAR standards. An ENERGY STAR Conference is scheduled for December, 2005. A contract, with the Residential Energy Services Network (RESNET),

that is intended to promote energy efficient construction and energy efficient mortgages in NC is in the DOA approval process. RESNET will partner with Wachovia Mortgage, Countrywide Home Loans and Fannie Mae to deliver this project.

- **SEP 4-1:** The North Carolina Utilities Commission is encouraged to promote policies that create diversity in energy supply such as natural gas, solar energy, wind energy, biomass, and hydrogen from renewable sources with particular emphasis on in-state energy development. Technical discussions regarding an interconnection policy that details liability, hardware, and rate issues have taken place under facilitation from the NCSC. A detailed docket brief describing these issues has been filed with the NCUC in August 2004. The NCUC annually reviews fuel diversity in generation as a factor of the integrated resource planning process. In addition, the NCUC continues to encourage and support participation in NC GreenPower, a statewide effort to develop renewable generation in NC. NC GreenPower has announced contracts with a number of solar and biomass facilities in the state. A biomass assessment project has been completed by NC A&T. This project characterized crop residues and forest wastes to determine energy content and amount of waste generated and available for use.
- **SEP 4-5:** Because the December, 2002, ice storm raised public interest in use of distributed generation (i.e., in facilities used as public shelters, residential housing, etc.), the State Energy Office should study distributed generation and appropriate applications. The Center for Energy Research and Technology conducted four Distributed Generation Workshops: in Greensboro on 10/28/03, in Flat Rock on 3/30/04, in Wilmington on 6/16/04 and in Charlotte on 6/18/04.
- **SEP 5-4:** The State Energy Office, Department of Agriculture, and Department of Environment and Natural Resources should support landfill methane gas projects through direct grants and loans based on need, as well as technical assistance. A landfill gas steering committee, formed as a result of the first NC Biomass Conference, has identified landfill gas development barriers and strategies, and held a statewide landfill gas conference for December 10, 2004. As follow-up to the conference the landfill gas committee has met with NCUC Public Staff to address regulatory concerns relative to developing landfill gas opportunities. SEO continues to support landfill gas projects with four active projects (Avery, Wilkes, Jackson, and Watauga Counties). Also, technical support is being provided to assess feasibility of sites in Wilson and Wayne Counties and in the City of Durham. An earlier project at Yancey-Mitchell landfill has successfully used energy from the landfill for operation of buildings, greenhouse, kiln, and glass-blowing facilities.
- **SEP 6-1:** A Solar Schools Program should be developed and incorporate renewable electricity generation, solar water heating, and daylighting to reduce fossil fuel use by schools, improve the quality of education, provide a real-world energy training lab, and make our citizens more aware of the potential for renewable resources. The SEO will fund the NEED Project's Schools Going Solar program in North Carolina. A total of six photovoltaic systems will be installed: five will be grid-tied, while the sixth will be a battery backup, PV-assisted UPS system. This program allows schools to receive photovoltaic installations and solar energy curriculum and training programs to facilitate an understanding of solar energy and its diverse applications. With teacher training,

student materials, and the installation of a learning lab, these schools learn about renewable energy, nonrenewable energy, and the impact that energy use has on economics and the environment.

- **SEP 6-2:** The State Energy Office should work with the state's professional licensing boards to develop a certification program for renewable energy installers. The NCSC is a participant in the national photovoltaic installer training program that will result in certification of installers. The NC HealthyBuilt Homes program is developing training workshops for builders. The Renewable Energy Diploma Series is now offering classes through NCSU covering renewable energy technology. These classes include field installation activities.
- **SEP 7-1:** North Carolina statutes should require that designers of all new public buildings provide estimates of projected energy consumption and energy costs for the building prior to construction. A beginning point for required estimation of whole building energy use was made through 2001 Session HB 1272. This legislation requires state agencies to use life-cycle cost analysis over the economic life of the facility in selecting the optimum systems in constructing or renovating any *state* facility. ASUEC is preparing an analysis of a sampling of state buildings approved since passage of this requirement.
- **SEP 7-3:** The North Carolina Department of Administration should implement high performance building guidelines developed for North Carolina in all new public buildings and also develop and implement high performance guidelines for new public housing. A pilot program to evaluate state buildings constructed to High Performance Building Guidelines is underway.
- **SEP 7-4:** The North Carolina Department of Administration should develop performance contracting procedures and other ways to finance energy efficiency projects for state and local governments, university and public school systems, and public housing. The Department of Administration should provide technical support to implement performance contracting projects and provide quality assurance. The SEO has developed a standard template RFP and contract templates, as well as procedures, for performance contracting. The SEO and State Construction Office have developed a scope of work for the Museum of Art project and for a downtown government complex project. SEO has been providing technical assistance to universities, state agencies, K-12 schools and community colleges which are evaluating potential performance contracting projects.
- **SEP 7-5:** State agencies should lead by example by establishing a certain minimum level of electricity to be derived from renewable sources, such as the North Carolina GreenPower Program, or via installation of state-owned renewable energy projects. The SEO is buying the equivalent of 100% of its annual electrical load from NCGP. DENR is investigating options for NCGP purchase. A meeting was held with the State Budget Office to request clearance for state agencies to participate in the NC GreenPower Program.
- **SEP 7-6:** North Carolina Department of Administration should require that all state facilities with motors larger than 5 horsepower must develop a motor maintenance program. Under the Utility Savings Initiative program, a motor maintenance program is

under development with consultation from Advanced Energy Corporation and NCSU Industrial Extension personnel, as well as research into current and best practices.

- **SEP 7-7:** Local governments should be encouraged to implement the above actions and other energy efficiency programs. Through the EnergySmart Schools Initiative, NEED has delivered three conferences targeted towards school administrators, school business officials, school board members, energy and facilities managers, and curriculum directors to provide information on the best practices found in school districts and resources that the SEO and others can provide to K-12 schools to reduce energy costs. Local governments and schools have been invited and welcomed at a variety of USI training sessions, including five performance contracting workshops and the latest Energy Management Diploma series. Working with DPI, three strategic energy planning workshops were held for K-12 officials. Under USI, a coordinator position will be jointly funded for 05-06 for the Community College system to target 6 pilot colleges for a comprehensive energy efficiency program. A similar arrangement is proposed for DPI. On February 23, 2005, SEO staff members met with the Local Government Commission to encourage the implementation of energy efficiency, renewable and recycling projects by taking advantage of the Energy Improvement Loan Program.
- **SEP 8-1:** The State Energy Office should conduct a study on current compliance levels of residential and commercial buildings with the North Carolina state energy code. The study should make recommendations for improvements in compliance procedures and for energy code changes that are in the best interests of the state. ASUEC surveyed a small sample of 30 recently-constructed average residences to determine relative energy efficiency. Blower door, duct leakage tests, and other data were used to rate the energy performance of the homes. Some homes did not meet state energy code and none meet the preferred ENERGY STAR standard. Southface Energy Institute has also conducted energy analysis of newly constructed western NC homes. Energy simulation software was used to estimate the energy savings which would develop from improved energy codes and increased stringency of enforcement of codes. The energy analysis will also determine whether additional expenditures and resources to improve both the quality of the energy codes and their enforcement are justified. Over the upcoming nine months, ASUEC will analyze 20 additional homes using this software.
- **SEP 8-2:** The State Energy Office should create an Energy Code Enforcement Assistance Program to provide additional energy code enforcement and outreach officials to serve across the state. The state should consider whether adding a state surcharge on all local building permit fees to support the program is feasible. The SEO is planning an initial meeting with representatives from the Department of Insurance and Southface Energy Institute to discuss the enforcement of energy codes throughout the state. SEO contracted with Southface Energy Institute to lead training workshops on building code standards for inspectors in 2004. Eight workshops have been conducted in 2003 and 2004 in four locations around the state. Over 170 persons attended the workshops. Training was also provided to 6 special groups and organizations including ASHRAE, affordable home representatives, and AIA chapters. Southface Energy Institute – North Carolina Office continues to meet and work with the Department of Insurance to develop and implement the enforcement of energy codes throughout the state.

- **SEP 8-3:** At a minimum, the State Energy Office should encourage new manufactured homes to comply with the critical components of the state energy code for site-built residential units and promote ENERGY STAR manufactured homes. The program should include a comprehensive statewide training program on the benefits and details of higher efficiency units. The Center for Energy Research and Technology at NCA&T continues its work with manufactured housing. Palm Harbor Homes and Oakwood Homes provided testimonials confirming that the research at NC A&T has caused them to produce manufactured homes that save 25% more energy than the regular HUD-built home. The Manufactured Housing Institute also supplied testimonials about the importance of CERT's research for the manufactured housing sector. The Center for Energy Research and Technology at NCA&T is investigating various seer levels energy efficiency heat pumps for manufactured housing. They expect to obtain energy usage data which will be provided to manufactured housing manufacturers, retailers, advocacy groups, utilities and research organizations. In addition, they are planning developing training classes for the set-up contractors who site manufactured homes. East Carolina University's Upgrade & Save Program-Heat Pumps in Manufactured Homes has been expanded to include MH retailers and potential new home buyers in Pitt and sixteen surrounding counties of Beaufort, Bertie, Carteret, Craven, Duplin, Edgecombe, Greene, Halifax, Jones, Lenoir, Martin, Nash, Onslow, Pamlico, Wilson & Wayne. Subsidies are paid to the MH retailers who sell heat pump-upgraded homes. Thirty-seven MH retailers and several HVAC distributors/suppliers in the local are actively involved in this program. As of June, 2005, over 100 manufactured homes have been upgraded to heat pumps. We are working with ECU to expand "Upgrade & Save" to additional eastern NC counties next year. SEO and NC Cooperative Extension Service will provide consumer training on energy measures.
- **SEP 8-5:** The State Energy Office should develop a comprehensive, statewide promotional campaign for high performance buildings. The SEO is continuing its efforts to develop a statewide promotion of residential energy efficient/ENERGY STAR construction through a committee of stakeholders/interested parties that was formed in the 2nd quarter of 2004. Jeff Tiller (ASU) serves as Chairperson along with representatives of ENERGY STAR, Progress Energy, the Electric Membership Cooperatives, Duke Power, Greenville Utilities, Advanced Energy, the NC Solar Center and SEO staff. Several meetings have been held and agreement was reached on a promotional initiative that includes an online NC ENERGY STAR website. An ENERGY STAR Conference will be held December, 2005.
- **SEP 8-6:** The State Energy Office should continue its work to formulate and advance mortgage-based incentives for high performance new homes. In 2004, the SEO partnered with Residential Energy Services Network (RESNET), Fannie Mae, Countrywide and Wachovia to promote the Energy Efficient Mortgage Initiative. EEM Media events were held in Raleigh, Charlotte, Asheville, Wilmington, and Winston-Salem. The EEM recognizes lower operating costs of energy efficient homes and higher home values when homes are energy efficient. The EEM will increase affordability for home buyers, regardless of income, and encourage energy efficient housing in NC. In addition, the program has boosted the number of ENERGY STAR-labeled homes built in NC. A new contract with the (RESNET) is in the DOA approval process. It is intended to continue the promotion of energy efficient/ENERGY STAR residential construction and energy

efficient mortgages in NC. RESNET plans to add more lending partners to its existing group of Wachovia Mortgage, Countrywide Home Loans and Fannie Mae.

- **SEP 8-7:** The State Energy Office should provide training on high performance buildings to builders, subcontractors, architects and engineers, landscape architects, code enforcement officials, utility representatives, building investors, developers, financial institutions, real estate professionals, appraisers, home inspectors, renovation contractors, educators, and prospective homeowners. NCSC holds workshops on building design strategies that promote sustainable design principles. The Healthy Built Homes Program (HBH) is actively reaching out to builder organizations and has marketing incentives for builders who build to HBH standards. RESNET provided high performance building marketing training for utility representatives, appraisers and home energy raters in November, 2003, in Raleigh.
- **SEP 8-8:** The State Energy Office should provide training for building professionals on specific targeted technologies including residential daylighting, solar water heating, heat pump water heaters, new insulation products, and advanced HVAC systems and controls. NCSC holds workshops on renewable energy technologies for building professionals. ASU provided training in new technologies to affordable housing and solar industry representatives. A workshop on performance contracting for Public Housing Authorities is scheduled for October, 2004. As a part of its educational outreach, Mountain Housing Opportunities, Inc. held an open house that showcased its "Green Building Demonstration" sustainable building project. They also partnered with NC Healthy Built Homes, Asheville area home builders and the local Green Building Council to offer informational tours of this 15-unit low-income, green housing development. Sustainable building concepts and products, such as passive solar design, solar water heating and environmentally friendly products, are included in the project.
- **SEP 9-1:** The State Energy Office should work with appropriate state agencies to provide a design review service that focuses on energy-efficient components and holistic, high-performance, design strategies for new commercial buildings. The design review procedure should include a systematic life-cycle cost analysis of a variety of energy technologies and strategies for each project. The service should seek to upgrade new buildings to meet high performance building guidelines developed statewide. The NCSC is conducting a limited number of commercial design reviews that focus on addressing LEED requirements and objectives.
- **SEP 9-2:** The State Energy Office should promote and develop guidelines for performance contracts, conduct workshops, and provide technical assistance on developing performance contracting documents. The SEO, in conjunction with the State Construction Office and the Attorney General's Office, has completed a template RFP for use by all state agencies and universities engaged in performance contracting. Template contract documents have received final review by the Attorney General's Office. Currently, ASU, UNCG, NCA&T, DOA, and DOC are developing projects.
- **SEP 9-4:** The State Energy Office should promote the use of and provide training for commercial building energy analysis software to assist building owners with evaluating the best energy efficiency measures to implement in existing state buildings and other

commercial structures. SEO partnered with Southface Energy Institute to conduct eight Commercial Energy Codes training workshops. During the workshops, 180 attendees learned about DOE's commercial energy code software, COMcheck-EZ Software and the COMcheck Prescriptive Packages. Workshops were held in Raleigh, Nags Head, Chapel Hill and Charlotte.

- **SEP 9-5:** The State Energy Office should develop an energy audit program for existing commercial buildings to assist building managers with implementing the most energy efficient and cost effective improvements for commercial renovation projects. SEO contracted with Waste Reduction Partners to design a Self-Assessment Guide for Energy-Saving Opportunities for use by organizations ranging from non-profits to businesses to public institutions. The guide helps establish priorities and identify measures to be taken. Copies of the guide are available from SEO or Land-of-Sky COG or can be downloaded from SEO's website.
- **SEP 10-3:** North Carolina should evaluate whether facilities that repair or rewind motors should be certified or otherwise meet a state efficiency requirement. Through USI training, SEO promotes the use of Motor Master Plus software available free from DOE to evaluate replacement with premium efficiency motors instead of rewinding motors. NCSU IES also offers motor efficiency workshops.
- **SEP 10-5:** North Carolina should create investment tax credits and other incentives for new and/or retrofitted manufacturing equipment to encourage modernization and efficiency improvements.
- **SEP 10-8:** North Carolina should create policies and regulations for distributed generation in the state, including incentives for deployment of "clean" distributed generation. After a collaborative process encouraged by the NCUC, investor-owned utilities jointly filed Docket No. E-100, Sub 101 on 6/4/04 which included model small generation interconnection standards, associated application to interconnect, and interconnection contract forms. On 7/12/04, the NCUC issued an order allowing interested persons to intervene in this docket and to file written comments or reply comments. Initial comments were filed by the Attorney General and the NC Sustainable Energy Association. Reply comments are due to be filed by 9/24/04. The SEO has a lead role in the Southeast CHG Applications Center and the NC CHP Center. Both are working to advance distributed generation systems.
- **SEP 10-9:** The State Energy Office should sponsor workshops on industrial energy efficiency around the state directed at industrial facility operators, design and process engineers, and owners. The workshops will describe the state-of-the-art in efficient technologies and describe the results of ongoing research efforts. The training effort should also address water-conserving practices around the state. Through the Industrial Extension Service, the Energy Management Program provides workshops on industrial energy efficiency throughout the year. Workshops are conducted on the following areas: air compressors, chillers and cooling towers, energy efficient lighting, energy efficient motors and VSD's, HVAC, boilers, preventative maintenance, steam traps and steam systems.

- **SEP 12-1:** The State Energy Office should develop and sponsor training programs for community colleges and universities in fields related to energy efficiency and high performance buildings. Technical support is being provided to Wilson Tech and a commercial landfill gas company in an effort to use landfill gas at the college and also generate a training curriculum on landfill gas generation and application. A-B Tech is being provided with technical support to train community colleges in energy management and performance contracting.
- **SEP 12-2:** The State Energy Office should assist in the coordination of energy education programs with museums and help create an energy museum "on wheels" using existing resources, such as the Science House at NCSU or the Museum of Life Science, wherever possible. The EV Challenge program utilizes a mobile classroom with exhibits, video, and a red Spitfire (converted from gasoline engine to electric battery) for presentations to high schools across the state.
- **SEP 12-3:** The State Energy Office should sponsor regional "renewable demonstration centers" or, whenever possible, use existing ones (e.g. demonstration centers such as the North Carolina Solar House and the EnergyXchange, museums such as the Museum of Life and Science, Discovery Place). The alternative fuel vehicle demonstration facility at the NCSC is developing new displays to highlight the range of alternative fuels that can be produced. Negotiations are underway with the Museum of Natural Science regarding a renewable energy demonstration.
- **SEP 12-4:** The State Energy Office should create energy internships or apprenticeships for graduating college students and high school students to create the next generation of energy professionals. The SEO has had three interns through the Youth Advocacy & Involvement Office and two volunteers who assisted with special projects for the staff. A verbal agreement has been made with Duke University's Nicholas School of the Environment to support up to four graduate work/study students for a full school year on energy/environmental projects. An energy management student intern will be funded under USI for UNC Asheville for year 05-06.
- **SEP 12-5:** The State Energy Office should provide a statewide award (e.g., a college scholarship) for the most outstanding energy-related science demonstration/experiment at the state science fair.
- **SEP 12-6:** The State Energy Office and the UNC System should help the Education Departments of colleges and universities develop coursework for junior and senior undergraduates and graduate students in energy education. SEO programs include the Model Solar Fuel Cell Cars project which takes air quality and alternative fuels information to middle school students. An annual competition includes several categories with the overall championship team rewarded with a trip to the national event to represent the state. Several SEO-sponsored programs train current K-12 teachers in energy and environmental issues. These include NEED, EV Challenge, Junior Solar Sprint, and Model Solar Fuel Cell Cars.
- **SEP 12-7:** The State Energy Office and the state's colleges and universities should help Community Colleges and other vocational schools develop coursework in energy efficiency and renewable energy to help spur the industry; such as training carpentry

students in energy efficient, passive solar building design and construction. Include this training in voc-tech courses in high schools. Technical support is being provided to Wilson Tech and a commercial landfill gas company in an effort to use landfill gas at the college and also generate a training curriculum on landfill gas generation and application. A-B Tech is being provided with technical support from the SEO to train community colleges in energy management and performance contracting.

- **SEP 12-8:** The State Energy Office should provide training to licensed professionals in the homebuilding industry focusing on energy efficiency and renewable energy sources to promote industry awareness and implementation of these technologies. A range of workshops is offered by the NCSC on green building topics including; green building, passive solar design, photovoltaics, solar hot water technology, and energy calculations. The Healthy Built Homes program conducts workshops on greenbuilding and provides marketing incentives for builders to incorporate green building practices. Southface conducted Residential and Commercial Energy Code workshops in Nags Head, Chapel Hill, Charlotte, and Raleigh. High Performance Home Workshops were held in Greenville, Raleigh, and Charlotte. RESNET conducted a North Carolina Energy Rater Training Workshop in Raleigh.
- **SEP 12-9:** The State Energy Office should support development of a comprehensive information outreach program for consumer questions about saving energy and using renewables in their homes and businesses; information hotline via a toll-free telephone number; informative Web Page containing a wide array of publications available on-line; resources that include up-to-date information on renewables and energy efficient buildings, industrial facilities, and vehicles, as well as data on energy sources in the state; information on energy-producing facilities; environmental information related to energy consumption; and other energy-related information. Brief fact sheets to address energy conservation and efficiency issues have been prepared by Waste Reduction Partners. Topics include vending machines, upgrading to T-8 fluorescent lamps, occupancy sensors, computer monitors, drinking fountains and water coolers, and task lighting. Several additional topics are being developed. This information will be helpful to energy managers in a variety of buildings, whether state-owned, K-12 schools, local government, or commercial. An energy conference, accessible to all sectors and audiences seeking energy-related information, was held in March, 2004 and will be held annually in the future. The SEO will broaden its efforts in public education to include a series of consumer-oriented trainings to be conducted through the NC Cooperative Extension Service. Extension agents will be trained and offer training to consumers about home energy efficiency. Outreach tools also include distribution of energy kits to consumers and professional energy audits in pilot counties. In our efforts to continue promoting all of the current residential energy-efficient programs which meet or exceed the ENERGY STAR standards, the SEO and ASU have launched an NC ENERGY STAR Website: http://www.ncenergystar.org. The NC ENERGY STAR Website, which is accessible from our own SEO website, offers information and links to utilities and other organizations who market energy-efficiency housing programs across the state.
- **SEP 12-10:** North Carolina should encourage schools to reduce school operating budgets by installing energy efficiency and renewable energy systems. NEED Smart Schools and

energy education workshops for K-12 officials were held in Asheville, Chapel Hill, and Wilmington. SEO and DPI held Strategic Energy Planning workshops in four locations for K-12 officials.

- **SEP 12-12:** The State Energy Office should work in partnership with the State Department of Public Instruction to plan school energy-related initiatives and include a representative for energy-use in school facilities on the Energy Policy Council.
- **SEP 12-14:** The State Energy Office should sponsor a program to install solar equipment or other sustainable energy technologies on school buildings in every school district in the state. NEED has been awarded a contract to install photovoltaic systems on six schools in NC. There are also 6 solar charging stations operating at high schools in NC. These charging stations operate in conjunction with the EV Challenge program and provide solar charging of electric cars. Demonstration water source heat pumps have been successfully tested on mobile classroom units by NCSU. In addition, a high performance mobile classroom is being monitored for performance by the NCSC. Both projects have potential for replication in many schools. SEO will fund the NEED Project's Schools Going Solar program in North Carolina. A total of six systems will be installed. Five will be grid-tied while the sixth will be a battery-backup, PV-assisted UPS system.
- **SEP 12-15:** The North Carolina Community College System should require that the community colleges' curricula provide a building science course, an energy design course for drafting programs, and a solar/renewable energy technology class. The SEO provided technical assistance to Wilson Tech and A-B Tech in design of curriculum for efficiency and renewable energy areas.
- **SEP 12-16:** The State Energy Office should establish a central repository for energy information. This energy data and policy analysis center should develop baseline information on energy consumption by state and local governmental entities. The center should also provide policy analysis for existing and proposed state energy policies. A database has been created to record summary utility use and cost data for state agencies and universities. The SEO is also working with the Dept. of Correction to track utility use, costs and inmate populations and square feet of building space with a web-based utility accounting program. Plans are underway to create an integrated database to house information from other agencies.

ANNEX B TO RCI Mitigation Option Descriptions:

Printouts of Selected Portions of Worksheets Used to Prepare Estimates of Costs and Benefits of Residential, Commercial, and Industrial Mitigation Options

Printouts below reflect status of analyses as of 6/6/2007

Estimate of Mitigation Option Costs and Benefits for North Carolina RCI GHG Analysis

Common Assumptions for North Carolina RCI GHG Analysis

Date Last Modified: 5/31/2007 D. Von Hippel/A Bailie

Common Assumptions

Real Discount Rate	5%	
Levelized, Avoided Costs (2006-2020, 2005$)		
Electricity - Sales-Weighted Average	$57	$/MWh
Derived from rates for Qualifying Facilities from Duke Power, Progress Energy, and Dominion Resource Services. See "AvCost" worksheet in this workbook.		
Electricity - Residential	$57	$/MWh
Electricity - Commercial	$57	$/MWh
Electricity - Industrial	$57	$/MWh
Levelized Costs not differentiated by sector for this analysis.		
Natural Gas	$8.0	$/MMBtu
Note: In the absence (as of 12/12/06) of NC-specific avoided gas costs, we derive a placeholder estimate for NC avoided gas costs by starting with average 2005 NC citygate gas costs and escalating costs based on escalation in weighted-average regional AES2006 estimates for gas cost by sector. These values should be replaced by NC-specific costs when and if available.		
Prices		
Electricity Price - Sales-Weighted, Levelized	$66	$/MWh
Prices are based on DOE data for prices in 2005 http://www.eia.doe.gov/cneaf/electricity/esr/esr_sum.html. Changes from 2006 to 2020 are based on the relative changes in projected SERC reliability Corporation region prices in US DOE Annual Energy Outlook 2006 (same % changes). AEO 2006 projects prices to declining to below 2005 levels from 2008 onward.		
Electricity - Residential Prices (Levelized, 2006-2020)	$77	$/MWh
Electricity - Commercial Prices (Levelized, 2006-2020)	$63	$/MWh
Electricity - Industrial Prices (Levelized, 2006-2020)	$47	$/MWh
Natural Gas (Delivered, RCI sales-weighted average)	$10.2	$/MMBtu
Natural gas prices are estimated as described for electricity above.		
Natural Gas - Residential Prices (Levelized, 2006-2020)	$12.6	$/MMBtu
Natural Gas - Commercial Prices (Levelized, 2006-2020)	$10.2	$/MMBtu
Natural Gas - IndustrialPrices (Levelized, 2006-2020)	$7.5	$/MMBtu
Biomass - All Users	$2.4	$/MMBtu
Estimate based on national study of state-by-state biomass resource resource assessments--see worksheet "Biomass_Data" in this workbook. Price equivalent of $38/dry ton at 16 MMBtu/dry ton. Replace with more NC-specific estimates (for example, from AF group when available).		
Coal - Industrial Users	$2.4	$/MMBtu
average coal heat content of 26.75 MMBTU/ton, based on 2001 USDOE/EIA data. USDOE/EIA figures for 2005 from suggest NC average coal price of $65.25 per ton for coal for "Other Industrial Users". www.eia.doe.gov/cneaf/coal/page/acr/table34.html		
Oil - Distillate/Diesel	$13.4	$/MMBtu
USDOE/EIA data gives NC average prices for heating oil of $1.846 per gallon in 2005/06 heating season. This cost does not include fuel taxes. An appendix to the 2006 Annual Energy Outlook by USDOE/EIA (see http://www.eia.doe.gov/oiaf/aeo/pdf/appendixes.pdf) lists an energy content for distillate oil of 5.799 MMBtu/bbl, or 0.138 MMBtu/gallon.		
LPG	$12.3	$/MMBtu
USDOE/EIA data gives NC average prices for propane of $1.846 per gallon in 2005/06 heating season. This cost does not include fuel taxes. Prices expressed on $/MMBtu basis a conversion factor of 0.09133 MMBtu/gallon (see "Fuel Data" woksheet)		
Landfill Gas - All Users	$5.0	$/MMBtu
Placeholder Estimate		
Biogas Gas - All Users	$5.0	$/MMBtu
Placeholder Estimate		

Emission Rates, etc.	2010	2020	Units
Electricity T&D losses (fraction of total generation)	6.0%	5.6%	

Pasted from (not linked to) updated ("Revised GHG forecast - version 1.2.xls") inventory and forecast, and as used in Energy Supply options analysis (row 543 of "Assumptions (revised)" worksheet).

Avoided electricity emissions rate	0.880	0.713	tCO_2/MWh

Assumes that reductions in electricity generation requirements through 2010 will come from the average emissions rate of then-existing fossil-fueled sources; by 2020 the predominant effect is assumed to be a reduction in reference case new coal and gas builds during the 2010-2020 period.

Notes	2010	2020	Units

Multi-Gas Emission Factors

Except as noted, the following emission factors are calculated from values in the North Carolina Inventory and Forecast prepared for the CAPAG, and reflect the average emissions in 2000 per BTU and physical amount of fuel. They include combustion CH4 and N20 as well as CO2 emissions for consistency with the inventory.

	tCO_2e/billion BTU	
LPG - RCI	63.425	assumed equal to CO_2 factor for propane
Coal - RCI	92.961	
Natural Gas - RCI	52.071	
Biomass - RCI	2.793	
Oil - RCI	74.342	assumed equal to CO_2 factor for misc pet prods
Landfill Gas - RCI	0.260	

As suggested by CAPAG Agriculture, Forestry and Waste TWG. This value excludes benefits from capture and use of methane that would have escaped from landfills, as those benefits are captured in the AFW TWG analysis.

Biogas - RCI	0.260	*Placeholder Value--assumed same as landfill gas for now--May in fact be negative*

GDP Deflators (to 2005$)	Cost Year	Index
	1997	1.18
	1998	1.16
	1999	1.15
	2000	1.12
	2001	1.09
	2002	1.08
	2003	1.05
	2004	1.03
	2005	1.00

Natural Gas Conversion	1.03	million Btu/ thousand cf
Electricity Conversion	3413	MMBTU/ GWh

Estimate of Mitigation Option Costs and Benefits for North Carolina RCI GHG Analysis

GHG Emissions Totals for North Carolina RCI GHG Analysis

Date Last Modified:	*9/12/2007*	*D. Von Hippel/A Bailie*

Summary Results and Totals for RCI Mitigation Options

	Option Name	GHG Reductions ($MMtCO_2e$) 2010	GHG Reductions ($MMtCO_2e$) 2020	Cost-Eff ($/tCO_2e$)	NPV 2007-2020 ($million)	Cumulative Emissions Reductions (MMt CO_2e, 2007-2020)	
RCI-1	Demand Side Management Programs for the Residential, Commercial and Industrial Sectors --Recommended Case: "Top-ten States" EE Investment	1.9	11.6	-$25	-$1,895	77.1	RCI-1
RCI-2	Expand Energy Efficiency Funds	1.5	8.0	-$25	-$1,346	54.8	RCI-2
RCI-3	Energy Efficiency Requirements for Government Buildings	0.0	1.1	-$14	-$88	6.4	RCI-3
RCI-4	Market Transformation and Technology Development Programs	0.0	2.0	-$32	-$339	10.5	RCI-4
RCI-5	Improved Appliance and Equipment Efficiency Standards	0.0	1.0	-$63	-$336	5.3	RCI-5
RCI-6	Building Energy Codes	0.5	3.5	-$17	-$400	23.1	RCI-6
RCI-7	"Beyond Code" Building Design Incentives and Targets, Incorporating Local Building Materials and Advanced Construction	0.7	5.2	-$14	-$494	34.2	RCI-7
RCI-8	Education (Consumer, Primary/Secondary, Post-Secondary/ Specialist, College and University Programs)	Not Quantified					RCI-8
RCI-9	Green Power Purchasing (required for state facilities) and Bulk Purchasing Programs for Energy Efficiency or Other Equipment	0.1	0.5	$3	$11	3.5	RCI-9
RCI-10	Distributed Renewable and Clean Fossil Fuel Power Generation	1.2	4.6	$12	$392	33.5	RCI-10
RCI-11	Residential, Commercial, and Industrial Energy and Emissions Technical Assistance and Recommended Measure Implementation	0.5	2.1	-$33	-$494	14.9	RCI-11
	Total Gross Savings with RCI-1 Recommended Case	6.4	39.7	-$19	-$4,990	263.3	Total of Options

Adjustment for Estimated Overlap Between RCI Options						
Overlap between RCI Options with RCI-1 Recommended Case: "Top-ten States" EE Investment						
RCI-2, Overlap with RCI-1	0.5	2.41		-$404	16.4	***See Note 2***
RCI-3, Overlap with RCI-1 and RCI-2	0.0	0.23		-$18	1.3	***See Note 3***
RCI-4, Overlap with RCI-1 through RCI-3	0.0	0.41		-$68	2.1	***See Note 4***
RCI-5 Overlap with RCI-1 through RCI-4	0.0	0.00		$0	0.0	***See Note 5***
RCI-6 Overlap with RCI-1 through RCI-5	0.0	0.0		$0	0.0	***See Note 5***
RCI-7, Overlap with RCI-1 through RCI-6	0.3	2.6		-$247	17.1	***See Note 6***
RC-9, Overlap with Other Quantified Policies	0.0	0.1		-$13	0.2	***See Note 7***
RCI-10 Overlap with Other Quantified Policies	0.0	0.0		$0	0.0	***See Note 8***
RCI-11 Overlap with Other Quantified Policies	0.3	1.0		-$247	7.5	***See Note 9***
Total Estimated Overlap Among RCI Policies (RCI-1 Case 2)	1.06	6.73		-$997	44.6	
Total Savings Net of Overlaps with RCI-1 Recommended Case	5.3	33.0	-$18	-$3,994	218.7	

Additional Emissions Savings from Recent Actions (not included in forecast or in policy options above)

	Option Name	GHG Reductions ($MMtCO_2e$) 2010	GHG Reductions ($MMtCO_2e$) 2020		Cumulative Emissions Reductions (MMt CO_2e, 2007-2020)
RCI-1	Demand Side Management Programs for the Residential, Commercial and Industrial Sectors	*0.3*	*0.7*		6.2
RCI-2	Expand Energy Efficiency Funds	*0.2*	*0.4*		3.6
RCI-6	Building Energy Codes	*0.0*	*0.0*		0.0
RCI-9	Green Power Purchasing (required for state facilities) and Bulk Purchasing Programs for Energy Efficiency or Other Equipment	*0.0*	*0.0*		0.3
	Total	0.5	1.2		10.1

Total Emissions Reductions Net of Overlaps (including recent actions), with RCI-1 Recommended Case	5.8	34.2		228.8

TABLE BELOW SHOWS NET ADJUSTED SAVINGS BY OPTION FOR CASE WITH RCI-1 --Recommended Case: "Top-ten States" EE Investment.

	Option Name	GHG Reductions 2010	GHG Reductions 2020	Cost-Eff ($/tCO2e)	NPV 2006-2020 ($million)	Cumulative Emissions Reductions (MMt CO2e, 2006-2020)
RCI-1	Demand Side Management Programs for the Residential, Commercial and Industrial Sectors	1.9	11.6	-$25	-$1,895	77
RCI-2	Expand Energy Efficiency Funds	1.1	5.6	-$25	-$943	38
RCI-3	Energy Efficiency Requirements for Government Buildings	0.0	0.9	-$14	-$70	5
RCI-4	Market Transformation and Technology Development Programs	0.0	1.6	-$32	-$271	8
RCI-5	Improved Appliance and Equipment Efficiency Standards	0.0	1.0	-$63	-$336	5
RCI-6	Building Energy Codes	0.5	3.5	-$17	-$400	23
RCI-7	"Beyond Code" Building Design Incentives and Targets, Incorporating Local Building Materials and Advanced Construction	0.3	2.6	-$14	-$247	17
RCI-8	Education (Consumer, Primary/Secondary, Post-Secondary/ Specialist, College and University Programs)	Not Quantified				
RCI-9	Green Power Purchasing (required for state facilities) and Bulk Purchasing Programs for Energy Efficiency or Other Equipment	0.1	0.4	$7	$24	3
RCI-10	Distributed Renewable and Clean Fossil Fuel Power Generation	1.2	4.6	$12	$392	33
RCI-11	Residential, Commercial, and Industrial Energy and Emissions Technical Assistance and Recommended Measure Implementation	0.3	1.0	-$33	-$247	7
	Total Savings	5.3	33.0	-$18	-$3,994	219

NOTES ON ESTIMATES OF OVERLAP BETWEEN POLICIES

Note 2:
The overlap between RCI-2 and RCI-1 at the at the "Recommended Case: 'Top-ten States' EE Investment" is assumed to be approximately 30%, as the sum of the two options at this RCI-1 level approach the level of "Achievable Cost-effective Energy Savings" noted above.

Note 3:
Assumes an overlap between RCI-3 and RCI-1 and -2 of 20%, which assumes relatively few government-sector improvements are subsidized by utility programs or energy efficiency funds.

Note 4:
RCI-4, Regional Market Transformation, could overlap with RCI-1 and RCI-2 if the same types of appliances, equipment, or other energy efficiency improvements, are targeted. Assuming a policy design that focuses on equipment targeted mostly at measures not covered by DSM programs, and taking into account that DSM programs will focus much more broadly than RCI-4, an overlap of no more than 20% on energy efficiency improvements through RCI-4 should be possible.

Note 5:
RCI-5 and RCI-6 have no overlap with RCI-1 through RCI-4, since savings from appliance efficiency and buildings in RCI-1 through -4 would be over and above standards and codes.

Note 6:
RCI-7 will likely have some measures that are installed using resources from RCI-1 and RCI-2. Assume an overlap of 50%

Note 7:
The Bulk Purchase component of RCI-9 will likely overlap with options RCI-1, -2, and -4. Assume an overlap of 30% in that component, but Green Power Purchasing would have no overlap with other RCI options.

Note 8:
RCI-10 would have no significant overlap with other RCI options.

Note 9:
RCI-11 would likely have substantial overlap with several other RCI options. Assume an overlap of 50%.

Estimation of Avoided Costs for North Carolina RCI GHG Analysis

Date Last Modified: 12/8/2006 D. Von Hippel/A Bailie

General approach used: Start with levelized 15-year avoided costs from Duke Power, Progress Energy, and Dominion Resource Services price schedules for qualifying facilities purchased power, as filed in late 2005 with the NCUC (Docket No. E-100, Sub 100), and create weighted average annual avoided costs by application of estimated weighting factors for on-peak and off-peak usage, and for the fraction of North Carolina's electricity supplied by each of the three utilities.

Calculation Using 15-year Levelized Rates from Duke Power (Cents/kWh), "Interconnected to Distribution Syst Non-Hydro

(Avoided costs derived from these rates are assumed reasonable to apply to end-user energy-efficiency and small distributed generation)

	Rates		Annual Hours		Fraction of Annual Energy Applicable	
Rate Category	Option "A"	Option "B"	Option "A"	Option "B"	Option "A"	Option "B"
Capacity Credit--on-peak	2.29	8.16	5832	2928	71.0%	38.6%
Capacity Credit--off-peak	0.51	1.26	2928	5832	29.0%	61.4%
Energy Credit--on-peak	4.54	4.68	4160	1853	55%	30%
Energy Credit--off-peak	3.36	3.71	4600	6907	45%	70%

	Option "A"	Option "B"
Implied Weighted Average Total Annual Energy plus Capacity Credit	5.78	7.92

Calculation Using 15-year Levelized Rates from Progress Energy (Cents/kWh), for Generators Not Connected to Transmission System [that is, connected to Distribution], and Non-Hydro

	Rates	Annual Hours	Fraction of Annual Energy Applicable
Capacity Credit--on-peak	2.252	2778	40%
Capacity Credit--off-peak	1.867	5982	60%
Energy Credit--on-peak	4.212	2778	40%
Energy Credit--off-peak	3.048	5982	60%
Implied Weighted Average Total Annual Energy plus Capacity Credit			5.53

Calculation Using 15-year Levelized Rates from Dominion Resource Services (Cents/kWh) for resources on line in 2006, and using "Option C"

	Rates	Annual Hours	Fraction of Annual Energy Applicable	
Capacity Credit (all)	0.546	8760	100%	
Energy Credit--on-peak	5.006	3911	50%	
Energy Credit--off-peak	4.123	4849	50%	
Credit for avoided line losses (applied to energy credit)				2.70%
Implied Weighted Average Total Annual Energy plus Capacity Credit				5.25

Calculation of Weighted-average Statewide Avoided Costs

Utility	Using Option	Avoided Cost Estimate From Above (cents/kWh)	Fraction of NC Sales*	Weighting Factor
Duke Power	A	5.78	43.41%	57.6%
Progress Energy		5.53	28.69%	38.1%
Dominion Resource Services		5.25	3.28%	4.4%

* Fractions for Dominion Resources Services (as Virgina Electric & Power Company), Progress Energy and Duke Power are derived from USDOE EIA sales data for 2005 (see "Utility_Sales" worksheet in this Workbook).

Implied Utility-weighted Average Avoided Cost	5.66	**cents/kWh (15-year levelized)**

Estimate of Mitigation Option Costs and Benefits for North Carolina RCI GHG Analysis

RCI-1 **Demand Side Management Programs for the Residential, Commercial and Industrial Sectors**

Date Last Modified: 5/29/2007 D. Von Hippel/A Bailie

Key Data and Assumptions	2010	2020/all	Units
First Year Results Accrue		2007	
Electricity			
Current/expected utility efficiency spending			
Fraction of electric utility revenues spent on efficiency		0.04%	
Fraction of gas utility revenues spent on efficiency		0.05%	

North Carolina Utilities Commission, ANNUAL REPORT of the NORTH CAROLINA UTILITIES COMMISSION Regarding Long Range Needs for Expansion of Electric Generation Facilities for Service in North Carolina, dated 30 November 2006, page 26, quoting "ED/SELC witness Prindle", suggests that North Carolina utilities (presumably as of 2006) invested an average of 0.04 percent of utility revenue in DSM programs.
No other gas utilities have this requirement or energy efficiency programs Note that the 0.04 percent estimate does not include the impacts of recent statements by an executive of Duke power suggesting plans to increase that company's DSM investment considerably. Document available as http://www.ncuc.commerce.state.nc.us/reports/lr2006.pdf. For natural gas, a recent rate case for Piedmont gas resulted in the company agreeing to invest $1.25 million per year in energy efficiency/conservation programs over 2006-2008 (information from NCUC staff and Docket G-9, sub 499, November 3, 2005 http://ncuc.commerce.state.nc.us/cgi-bin/webview/senddoc.pgm?dispfmt=&itype=Q&authorization =&parm2=YBAAAA70350B&parm3=000123283).

No other gas utility energy efficiency investments in NC have been noted. The estimate of gas utility investment here divides the $1.25 million figure referenced above by the total estimated NC-wide gas utility revenues in 2007.

Year that action begins		2006	
Year that target is achieved		2006	
Fraction of Statewide Electricity and Gas Sales Covered			
Residential		100%	Assumption
Commercial		100%	Assumption
Industrial		100%	Assumption
Recommended Case: "Top-ten States" EE Investment			
Assuned level of spending when programs fully phased-in		$25.90	per customer-yr
By 2012, this corresponds to approximately		1.50%	of Utility Revenue

This level of spending would placed North Carolina among the top ten states in DSM spending (as of 2003) as a percentage of electricity revenues according to the list compiled (page 21) in ACEEE's 3rd National Scorecard on Utility and Public Benefits Energy Efficiency Programs: A National Review and Update of State-Level Activity, by Dan York and Marty Kushler of the American Council for an Energy-Efficient Economy. Report No. U054, Dated October, 2005.

Increase in energy efficiency spending starting in year		2007	
Ramping up to offset post-2005 growth in emissions by year		2016	

This implementation timing interprets the goals set for RCI-1 ("At a minimum, utilities must offset projected growth in emissions from the inventory base year from RCI utility gas and electricity use...") to mean that by 2016, all growth in emissions from electricity generation and gas use since 2005 should be offset, with annual incremental growth in emissions offset thereafter. The calculations that follow are used to "phase in" the required annual savings calculated as above.

For Alternative Case 1 and Recommended Case, spending assumed to ramp linearly to full levels by:		2012	

This assumption is roughly consistent with the pattern of spending growth implied for the "offset growth" case..

Annual electricity efficiency savings needed to meet reduction target, offset case	2,532	2,647	GWh
Annual gas efficiency savings needed to meet reduction target, offset case	6,181	3,015	Billion Btu

Calculated based on savings targets and phase-in schedule above. Calculation approach for estimating revenues earmarked for energy efficiency programs (below): spending levels "back-calculated" based on savings per $ spent averages presented below.

Fraction of Sales by Sector Covered			
Residential		100%	Assumption
Commercial		100%	Assumption
Industrial		100%	Assumption

Levelized Cost of Electricity Savings	**$33**	$/MWh

*Estimated based on savings included in the GDS Report for the NC Utilities Commission, A Study of the Feasibility of Energy Efficiency as an Eligible Resource as Part of a Renewable Portfolio Standard for the State of North Carolina, dated 12/2006. See **Note 2**. The 2.9 cent/kWh average from the GDS report is based on a discount rate of 10 percent nominal, and has been recalculated using a real discount rate of 5%/yr to yield the value above. See "GDS calcs" worksheet in this workbook. By comparison, a report prepared for the Western Governors Association (CDEAC EE Report, 2006--See **Note 3**), which in turn is based on Funding and Savings for Energy Efficiency Programs in Program Years 2000 through 2004 (CEC Rogers, Messenger Bender 2005) and on The Fifth Northwest Electric Power and Conservation Plan (Northwest Power and Conservation Council 2005), cites an average levelized cost of electricity savings of $25/MWh.*

Electricity Savings per Program Spending (first year savings)	**8.0**	MWh/$1000 spent, or
	$125	$/MWh 1st yr savings

Based on rough average of several sources. Since 2000, NW utilities have achieved around 7 MWh/$1000 (T. Eckman, 2006, ttp://www.nwcouncil.org/energy/present/idaho.pdf), while CA utilities have averaged closer to 5 MWh/$1000 (M. Messenger, 2003, http://www.energy.ca.gov/reports/2003-09-24_400-03-022D.PDF). A calculation of the implied cost per unit first-year savings for the energy efficiency program defined for North Carolina in the GDS report (see reference above) yield program costs (including sponsor incentive costs and administration/marketing costs) on the order of $100 per kWh.

Avoided Delivered Electricity Cost	**$57**	$/MWh

See common assumptions ("Common Factors" worksheet in this workbook)

Natural Gas Savings per Program Spending	**72,700**	MCF/yr per $million
	74,881	MMBtu/yr per $million

Based on average cost of gas DSM programs reported in Tegen, S. and Geller, H., 2006. Natural Gas Demand-Side Management Programs: A National Survey, Southwest Energy Efficiency Project, www.swenergy.org.

Levelized Cost of Natural Gas Savings	**$2.1**	$/MMBtu

Based on the first year costs above and average measure lifetime assumption below

Assumed average measure lifetime	**8**	years
Avoided Delivered Natural Gas Cost	**$8.0**	$/MMBtu

See common assumptions

Other Data, Assumptions, Calculations	2010	2020/all	Units
Calculations used to estimate target spending levels			
During 2006-2020 period, implied new annual energy savings from:			
Current/expected electric utility spending	54	64	GWh
Current/expected gas utility spending	125	142	Billion Btu
Meeting RCI-1 Recommended Case Target--Electricity	716	1,252	GWh
Meeting RCI-1 Recommended Case Target--Gas	1,785	3,015	Billion Btu
Analysis			
RCI Electricity Sales Use *(from inventory)*	134,876	159,498	GWh
Residential	56,047	68,143	GWh
Commercial	50,710	67,461	GWh
Industrial	28,119	23,895	GWh
RCI Electricity Prices (statewide averages)			
Residential	$78	$75	$/MWh
Commercial	$63	$62	$/MWh
Industrial	$48	$47	$/MWh
2005 gas prices are from EIA. http://tonto.eia.doe.gov/dnav/ng/ Changes in sectoral gas prices indexed to DOE EIA Annual Energy Outlook 2006 national forecast.			
Total Electricity Revenues (RCI, statewide)	$8,934	$10,414	$million
Residential	$4,376	$5,083	$million
Commercial	$3,219	$4,208	$million
Industrial	$1,339	$1,122	$million

RCI Gas Sales *(from inventory)*	250,711	285,286	Billion Btu
Residential	78,325	95,284	Billion Btu
Commercial	50,208	56,195	Billion Btu
Industrial	122,178	133,807	Billion Btu
Conversion Factor: Million Btu per Thousand Cubic feet		1.03	MMBtu/Mcf
RCI Gas Prices (statewide averages, real 2005 dollars)			
Residential	$12.46	$12.32	$/MMBtu
Commercial	$10.15	$9.80	$/MMBtu
Industrial	$7.32	$7.13	$/MMBtu

2005 gas prices are from EIA (see "NGPrices current" worksheet in this workbook). http://tonto.eia.doe.gov/dnav/ng/xls/ng_sum_lsum_dcu_SNC_a.xls. Changes in sectoral gas prices indexed to future gas prices from DOE EIA Annual Energy Outlook 2006 national forecast.

Total Implied Gas Revenues (RCI, statewide)	$2,380	$2,679	$million
Residential	$976	$1,174	$million
Commercial	$510	$551	$million
Industrial	$894	$955	$million

Spending on Efficiency Programs

Current/expected utility efficiency spending

Efficiency Spending, Electric Utilities	$3.6	$4.2	$million
Fraction of Electricity Revenues Spent	0.04%	0.04%	
Efficiency Spending, Gas Utilities	$1.2	$1.3	$million
Fraction of Gas Revenues Spent	0.05%	0.05%	

Recommended Case: "Top-ten States" EE Investment

Efficiency Spending, Electric Utilities	$89.5	$156.5	$million
Fraction of Electricity Revenues Spent	1.00%	1.50%	
Efficiency Spending, Gas Utilities	$23.8	$40.3	$million
Fraction of Gas Revenues Spent	1.00%	1.50%	

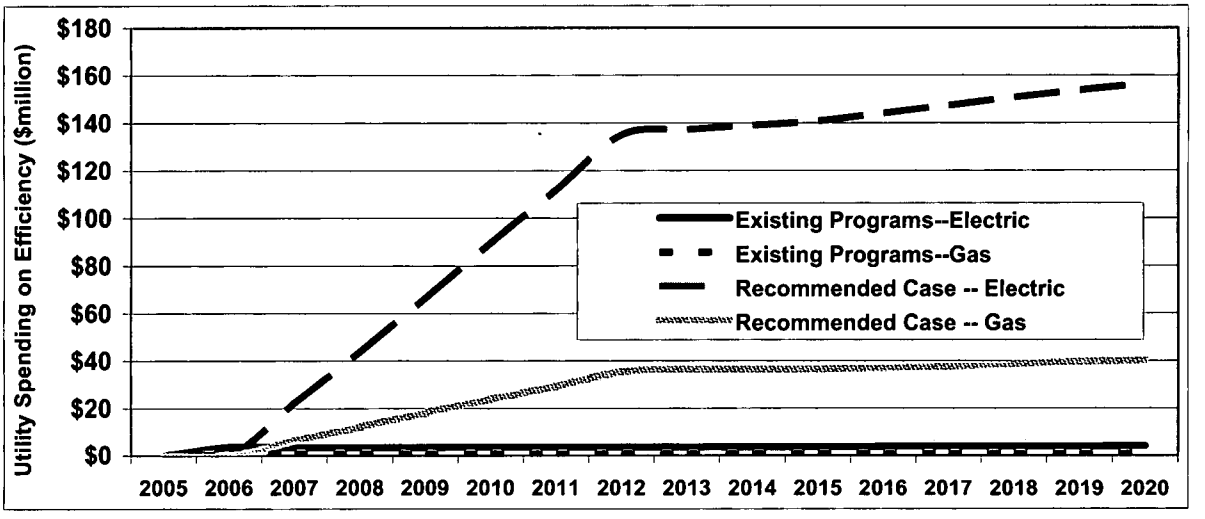
Average Generation Level Capacity Savings per Unit Customer Energy Savings	0.219	MW/GWh

Estimated from electrical energy and peak power savings for "Achievable Cost-effective Electricity Savings Base Case for North Carolina" scenario as indicated on page 145 of A Study of the Feasibility of Energy Efficiency as an Eligible Resource as Part of a Renewable Portfolio Standard for the State of North Carolina, dated December 2006, and prepared as a Report for the North Carolina Utilities Commission by GDS Associates, Inc. Note that this "peak factor" indicates that the efficiency measures included in the indicated scenario are about twice as likely to provide savings on-peak as efficiency savings that provide the same level of energy savings at all times.

Additional Results	2010	2020	Units
Current/expected utility efficiency spending			
Reduction in Electricity Use (Cumulative)	262	854	GWh
as % of overall projected sales in that year	0.2%	0.5%	
Reduction in Generation Requirements	279	909	GWh
GHG Emission Savings	**0.2**	**0.6**	$MMtCO_2e$
Reduction in Gas Use	601	1,949	Billion Btu
as % of overall projected sales in that year	0.2%	0.7%	
GHG Emission Savings, Gas	**0.0**	**0.1**	$MMtCO_2e$

Original Case: Spending to increase energy efficiency spending sufficient to offset growth in emissions			
Reduction in Electricity Use (Cumulative)	6,153	32,803	GWh
as % of overall projected sales in that year	4.6%	20.6%	
Incremental Reduction in Generation Requirements	6,549	34,914	GWh
Incremental GHG Emission Savings, Electricity	**5.8**	**24.9**	$MMtCO_2e$
Reduction in Gas Use (Cumulative)	14,370	58,781	Billion Btu
as % of overall projected sales in that year	5.7%	20.6%	
Incremental GHG Emission Savings, Gas	**0.7**	**3.1**	$MMtCO_2e$
Alternative Case 1: Mid-Range EE Investment			
Reduction in Electricity Use (Cumulative)	591	4,361	GWh
as % of overall projected sales in that year	0.4%	2.7%	
Incremental Reduction in Generation Requirements	629	4,642	GWh
Incremental GHG Emission Savings, Electricity	**0.6**	**3.3**	$MMtCO_2e$
Reduction in Gas Use (Cumulative)	1,512	10,659	Billion Btu
as % of overall projected sales in that year	0.6%	3.7%	
Incremental GHG Emission Savings, Gas	**0.1**	**0.6**	$MMtCO_2e$
Recommended Case: "Top-ten States" EE Investment			
Reduction in Electricity Use (Cumulative)	1,777	13,109	GWh
as % of overall projected sales in that year	1.3%	8.2%	
Incremental Reduction in Generation Requirements	1,892	13,953	GWh
Incremental GHG Emission Savings, Electricity	**1.7**	**9.9**	$MMtCO_2e$
Reduction in Gas Use (Cumulative)	4,545	32,039	Billion Btu
as % of overall projected sales in that year	1.8%	11.2%	
Incremental GHG Emission Savings, Gas	**0.2**	**1.7**	$MMtCO_2e$
Implied peak power savings from			
Current/expected utility savings	57	187	MW
Spending to increase energy efficiency spending sufficient to offset growth in emissions	1,347	7,184	MW
Alternative Case 1: Mid-Range EE Investment	130	955	MW
Recommended Case: "Top-ten States" EE Investment	389	2,871	MW

Economic Analysis			
Recommended Case: "Top-ten States" EE Investment			
--Electricity Programs			
Net Present Value (2007-2020)		**-$1,167**	$million
Cumulative Emissions Reductions (2007-2020)		**67**	$MMtCO_2e$
Cost-Effectiveness		**-$17**	$/tCO_2e$
--Gas Programs			
Net Present Value (2007-2020)		**-$728**	$million
Cumulative Emissions Reductions (2007-2020)		**10.4**	$MMtCO_2e$
Cost-Effectiveness		**-$70**	$/tCO_2e$
--Total of Electric and Gas Programs			
Incremental GHG Emission Savings, Electricity and Gas	**1.9**	**11.6**	$MMtCO_2e$
Net Present Value (2007-2020)		**-$1,895**	$million
Cumulative Emissions Reductions (2007-2020)		**77.1**	$MMtCO_2e$
Cost-Effectiveness		**-$25**	$/tCO_2e$



Notes and Sources

Note 1:

The "GDS Report" is available as
http://www.ncuc.commerce.state.nc.us/rps/NC RPS Energy Efficiency Report 12-06.pdf
Links to related NCUC documents on analysis of an RPS for NC (December 2006) are:
http://www.ncuc.commerce.state.nc.us/rps/NC RPS Report 12-06.pdf
http://www.ncuc.commerce.state.nc.us/rps/NC RPS Presentation to ERC 12-13-06.pdf

Note 2:

The Energy Efficiency Task Force Report to the Clean and Diversified Energy Advisory Committee of the Western Governors Association,
The Potential for More Efficient Electricity Use in the Western United States, January, 2006. This report is referred to here as the "WGA CDEAC EE report" and can be found at:
http://www.westgov.org/wga/initiatives/cdeac/Energy%20Efficiency-full.pdf.

Estimate of Mitigation Option Costs and Benefits for North Carolina RCI GHG Analysis

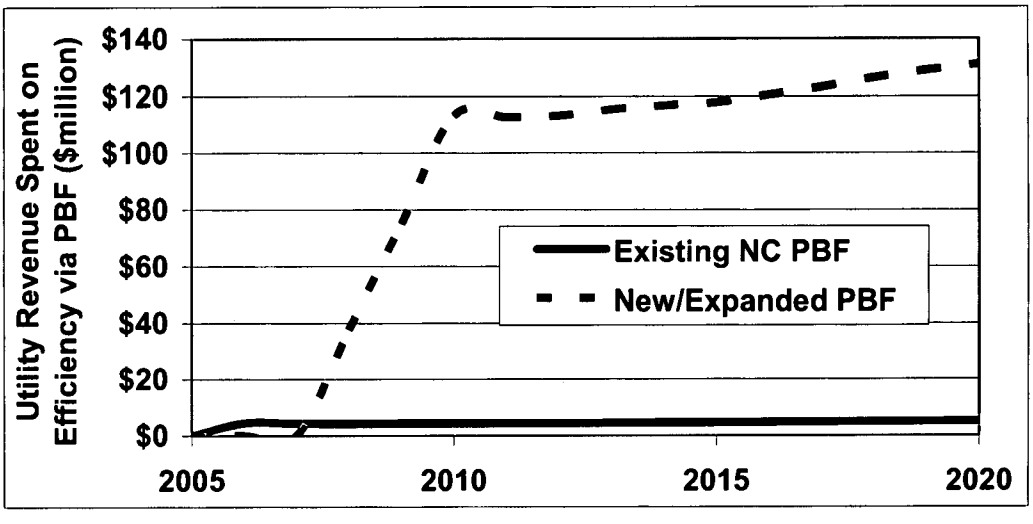
RCI-2 **Expand Energy Efficiency Funds**

Date Last Modified: *5/22/2007 D. Von Hippel/A Bailie*

Key Data and Assumptions	2010	2020/all	Units
First Year Results Accrue		2007	
Electricity			
Current/expected public benefits fund (PBF) spending			
At current rate	0.003567		cents per kWh electricity sales
Implied fraction of electric utility revenues funding current PBF		0.0496%	
As included in current Public Benefits Fund charge as approved by the NCUC (see, for example source in Note 1, below). Calculation based on 2005 average electricity price from USDOE EIA statistics (see "Utility_Sales" worksheet in this workbook).			
At current rate	0		cents per MMBtu gas sales
Implied fraction of gas utility revenues funding current PBC		0.0000%	
Rows above included in case needed. North Carolina Utilities Commission staff contacted when this analysis was prepared indicated that no PBF charge for gas utilities exists in NC at present.			
Year that current/expected action begins		2006	
Year that target is achieved (fully phased-in)		2006	
Fraction of Statewide Utility Sales Covered			
Residential		100%	Assumption
Commercial		100%	Assumption
Industrial		100%	Assumption
New/Expanded Public Benefits Fund			
Target public benefits funds collection as a fraction of revenue		1.0%	
Information from a national compilation on existing and planned electric utility spending on energy efficiency programs in other states was reviewed, and indicated spending in the range from a fraction of one percent to approximately three percent of utility revenues. On that basis, one percent (1%) of utility revenues was chosen as an appropriate public benefits charge goal for North Carolina at present. Value applies to both utility electric and gas sales.			
Year that action begins		2007	
Year that target is achieved		2010	
Fraction of Sales by Sector Covered			
Residential		100%	Assumption
Commercial		100%	Assumption
Industrial		100%	Assumption
Levelized Cost of Electricity Savings		$33	$/MWh
*Estimated based on savings included in the GDS Report for the NC Utilities Commission, A Study of the Feasibility of Energy Efficiency as an Eligible Resource as Part of a Renewable Portfolio Standard for the State of North Carolina, dated 12/2006. See **Note 1**. The 2.9 cent/kWh average from the GDS report is based on a discount rate of 10 percent nominal, and has been recalculated using a real discount rate of 5%/yr to yield the value above. See "GDS calcs" worksheet in this workbook. By comparison, a report prepared for the Western Governors Association (CDEAC EE Report, 2006--See **Note 2**), which in turn is based on Funding and Savings for Energy Efficiency Programs in Program Years 2000 through 2004 (CEC Rogers, Messenger Bender 2005) and on The Fifth Northwest Electric Power and Conservation Plan (Northwest Power and Conservation Council 2005), cites an average levelized cost of electricity savings of $25/MWh.*			
Electricity Savings per Program Spending (first year savings)		8.0	MWh/$1000 spent, or
		$125	$/MWh 1st yr savings
Based on rough average of several sources. Since 2000, NW utilities have achieved around 7 MWh/$1000 (T. Eckman, 2006, ttp://www.nwcouncil.org/energy/present/idaho.pdf), while CA utilities have averaged closer to 5 MWh/$1000 (M. Messenger, 2003, http://www.energy.ca.gov/reports/2003-09-24_400-03-022D.PDF). A calculation of the implied cost per unit first-year savings for the energy efficiency program defined for North Carolina in the GDS report (see reference above) yield program costs (including sponsor incentive costs and administration/marketing costs) on the order of $100 per kWh.			
Avoided Delivered Electricity Cost		$57	$/MWh
See common assumptions ("Common Factors" worksheet in this workbook)			
Natural Gas Savings per Program Spending		72,700	MCF/yr per $million
		74,881	MMBtu/yr per $million
Based on average cost of gas DSM programs reported in Tegen, S. and Geller, H., 2006. Natural Gas Demand-Side Management Programs: A National Survey, Southwest Energy Efficiency Project, www.swenergy.org.			
Levelized Cost of Natural Gas Savings		$2.1	$/MMBtu
Based on the first year costs above and average measure lifetime assumption below			
Assumed average measure lifetime		8	years
Avoided Delivered Natural Gas Cost		$8.0	$/MMBtu
See common assumptions			

Other Data, Assumptions, Calculations		2010	2020/all	Units
Analysis				
RCI Electricity Sales	*(from inventory)*	134,876	159,498	GWh
Residential		56,047	68,143	GWh
Commercial		50,710	67,461	GWh
Industrial		28,119	23,895	GWh
Conversion Factor:GWh/Billion Btu			0.29306	
RCI Electricity Prices (statewide averages, real 2005 dollars)				
Residential		$78	$75	$/MWh
Commercial		$63	$62	$/MWh
Industrial		$48	$47	$/MWh
2005 electricity prices are from EIA (see "Retail_Prices_Elec" worksheet in this workbook). http://tonto.eia.doe.gov/dnav/ng/ Changes in sectoral electricity prices indexed to DOE EIA Annual Energy Outlook 2006 national forecast.				
Total Implied Electricity Revenues (RCI, statewide)		$8,934	$10,414	$million
Residential		$4,376	$5,083	$million
Commercial		$3,219	$4,208	$million
Industrial		$1,339	$1,122	$million
RCI Gas Sales	*(from inventory)*	250,711	285,286	Billion Btu
Residential		78,325	95,284	Billion Btu
Commercial		50,208	56,195	Billion Btu
Industrial		122,178	133,807	Billion Btu
Conversion Factor: Million Btu per Thousand Cubic feet			1.03	MMBtu/Mcf
RCI Gas Prices (statewide averages, real 2005 dollars)				
Residential		$12.46	$12.32	$/MMBtu
Commercial		$10.15	$9.80	$/MMBtu
Industrial		$7.32	$7.13	$/MMBtu
2005 gas prices are from EIA (see "NGPrices current" worksheet in this workbook). http://tonto.eia.doe.gov/dnav/ng/xls/ng_sum_lsum_dcu_SNC_a.xls. Changes in sectoral gas prices indexed to future gas prices from DOE EIA Annual Energy Outlook 2006 national forecast.				
Total Implied Gas Revenues (RCI, statewide)		$2,380	$2,679	$million
Residential		$976	$1,174	$million
Commercial		$510	$551	$million
Industrial		$894	$955	$million
Public Benefits Fund Spending on Efficiency				
Recent Actions				
Fraction of Electricity Revenues Spent		0.0496%	0.0496%	
Efficiency Spending for Recent Actions (Electricity)		$4.4	$5.2	$million
Cumulative reduction in sales from existing PBF spending		0.131%	0.349%	(Electric)
Fraction of Gas Revenues Spent		0.0000%	0.0000%	
Efficiency Spending for Recent Actions (Gas)		$0.0	$0.0	$million
Cumulative reduction in sales from existing PBF spending		0.000%	0.000%	(Gas)
New/Expanded Public Benefits Funds				
Fraction of Electric Revenues Spent		1.0%	1.0%	
Efficiency Spending from New/Expanded PBF (Electricity)		$89.3	$104.1	$million
Fraction of Gas Revenues Spent		1.0%	1.0%	
Efficiency Spending from New/Expanded PBF (Gas)		$23.8	$26.8	$million

Additional Results	2010	2020	Units
Current/expected public benefits fund (PBF) spending			
Reduction in Electricity Use	177	557	GWh
as % of overall projected sales in that year	0.131%	0.349%	
Reduction in Generation Requirements	188	593	GWh
GHG Emission Savings from Electricity Use Reduction	**0.2**	**0.4**	$MMtCO_2e$
Reduction in Gas Use	0	0	Billion Btu
as % of overall projected sales in that year	0.000%	0.000%	
Reduction in Gas Consumption (*same as use at present*)	0	0	Billion Btu
GHG Emission Savings from Gas Use Reduction	**0.00**	**0.00**	$MMtCO_2e$
New/Expanded Public Benefits Fund			
Reduction in Electricity Use from New/Expanded PBF	1,420	9,079	GWh
as % of overall projected sales	1.1%	5.7%	(Electric)
Incremental Reduction in Generation Requirements	1,512	9,664	GWh
GHG Emission Savings	**1.3**	**6.9**	$MMtCO_2e$
Reduction in Gas Use	3,606	22,193	Billion Btu
as % of overall projected sales in that year	1.4%	7.8%	
Reduction in Gas Consumption (*same as use at present*)	3,606	22,193	Billion Btu
GHG Emission Savings from Gas Use Reduction	**0.2**	**1.2**	$MMtCO_2e$
Economic Analysis - New/Expanded Public Benefits Funds			
Net Present Value, Electricity Savings (2007-2020)		**-$829**	$million
Cumulative Emissions Reductions, Electricity (2007-2020)		**47.4**	$MMtCO_2e$
Cost-Effectiveness, Electricity		**-$18**	$/tCO_2e$
Net Present Value, Gas Savings (2007-2020)		**-$517**	$million
Cumulative Emissions Reductions, Gas (2007-2020)		**7.4**	$MMtCO_2e$
Cost-Effectiveness, Gas		**-$70**	$/tCO_2e$
Incremental GHG Emission Savings, Electricity and Gas	**1.5**	**8.0**	$MMtCO_2e$
Net Present Value, Electricity and Gas Savings (2007-2020)		**-$1,346**	$million
Cumulative Emissions Reductions, Electricity and Gas (2007-2020)		**54.8**	$MMtCO_2e$
Cost-Effectiveness, Electricity and Gas		**-$25**	$/tCO_2e$



NOTES AND DATA FROM SOURCES

Note 1:

Description of State Actions Policies: North Carolina, from USEPA Action Plans Database
http://yosemite.epa.gov/gw/StatePolicyActions.nsf/uniqueKeyLookup/MSTY5NM5VW?OpenDocument

Note 2:

The "GDS Report" is available as
http://www.ncuc.commerce.state.nc.us/rps/NC RPS Energy Efficiency Report 12-06.pdf
Links to related NCUC documents on analysis of an RPS for NC (December 2006) are:
http://www.ncuc.commerce.state.nc.us/rps/NC RPS Report 12-06.pdf
http://www.ncuc.commerce.state.nc.us/rps/NC RPS Presentation to ERC 12-13-06.pdf

Note 3:

The Energy Efficiency Task Force Report to the Clean and Diversified Energy Advisory Committee of the Western Governors Association,
The Potential for More Efficient Electricity Use in the Western United States, January, 2006. This report is referred to here as the "WGA CDEAC EE report" and can be found at:
http://www.westgov.org/wga/initiatives/cdeac/Energy%20Efficiency-full.pdf.

Estimate of Mitigation Option Costs and Benefits for North Carolina RCI GHG Analysis

RCI-3 **Energy Efficiency Requirements for Government Buildings**

Date Last Modified:	*6/1/2007 D. Von Hippel/A Bailie*

Key Data and Assumptions	2010	2020/all	Units
First Year Results Accrue		2011	

Based on goal set in Mitigation Option Design for RCI-3 (version dated 10/27/06) that reads "Commence with all buildings entering the design phase by 2010. Based on a state composite average, achieve a 20% reduction from a baseline fiscal year of 2002-03 in energy consumption per gross square foot per year for the entire North Carolina government existing building stock by 2027".

Electricity	2010	2020/all	Units
Levelized Cost of Electricity Savings		$35	$/MWh

Based on estimate in WGA CDEAC EE Report. (See Note 1, below.) Although this estimate is based on building efficiency improvements driven by code changes, it is on the order of estimates for the costs of efficiency improvements for "beyond code" changes included in a recent report by the Southwest Energy Efficiency Project (SWEEP--see Note 2). Value here adjusted for NC prices based on 7-year payback estimated in WGA CDEAC EE Report. (See Note 1 in RCI-6.)

Levelized Cost of Natural Gas Savings		$5.1	$/MMBtu

As estimated for RCI-6. Based on 7-year payback as estimated in WGA CDEAC EE Report. (See Note 1 in RCI-6.)

Avoided Electricity Cost		$57	$/MWh

See "AvCost" and "Common Factors" worksheets in this workbook.

Avoided Natural Gas Cost		$8.0	$/MMBtu

See "NG prices aeo2006" and "Common Factors" worksheets in this workbook.

Other Data, Assumptions, Calculations	2010	2020/all	Units

Inputs to/Intermediate Results of Calculation of Electricity and Gas Savings

Average Electricity and Gas Savings Beyond Code Levels (new government buildings)	0%	16%	

The description for this option currently includes a goal of 20 percent improvement in the entire NC building stock by 2027, and specifies that "New construction and major renovations of government buildings must meet LEED+ requirements." The values shown above for these parameters are initial assumptions.

Note in particular that the level of savings shown here is beyond that already included in Option RCI-6, and thus already includes an improvement in efficiency relative to average current practice.

Total Commercial Floorspace in North Carolina (million square feet)	2,427	2,780	

Estimated (see "NC_Activities_Est" worksheet in this workbook) based on USDOE EIA CBECS (comercial survey) data for the South Atlantic region, extrapolated using projected North Carolina population as a driver.

Est. area of new commercial space per year (million square feet)	35.7	36.6	

Calculated based on estimates above.

Implied Average Electricity Consumption per Square Foot Commercial Space in North Carolina as of 2005 (see ***Note 3***)		19.59	kWh/yr
Implied Average Natural Gas Consumption per Square Foot Commercial Space in North Carolina as of 2005 (see ***Note 3***)		19.09	kBtu/yr
Electricity Use per New/Renovated Commercial Sq. Ft. After RCI-6 Application	16.3	16.3	kWh/yr

Based on application of RCI-6 (20% efficiency improvement)--see calculations and notes in "RCI-6" worksheet in this workbook. with ultimate savings of 20 percent relative to current building codes

Nat. Gas Use per New/Renovated Commercial Sq. Ft. After RCI-6 Application	15.6	15.6	kBtu/yr

Assumes the same pattern of code improvement as for electricity use, as described above.

Implied Electricity Use per New/Renovated Commercial Square Foot After RCI-6 Application, Relative to Average in North Carolina as of 2005	83.0%	83.0%	
Implied Natural Gas Use per New/Renovated Commercial Square Foot After RCI-6 Application, Relative to Average in North Carolina as of 2005	83.0%	83.0%	
Required Net Elect/Gas Use per Square Foot New Government Space After RCI-3 Policy Relative to Average in North Carolina in 2005	First Year	75%	
	In 2020	67%	

Placeholder estimate, to be revised in consultation with TWG (based on pattern of improvement implied by meeting LEED energy specifications, as noted in RCI-3 Option Design).

Required Net Elect/Gas savings per Square Foot Existing Government Space After RCI-3 Policy Relative to Average in North Carolina in 2005	0.0%	11.8%	
Based on "20 percent improvement by 2027" as noted in RCI-3 Option Design.			
Government floorspace (including leased) by year (million square feet)	476	546	
Implied total electricity savings in existing buildings from RCI-3	-	1,236	GWh/yr
Implied total gas savings in existing buildings from RCI-3	-	1,205	GBtu/yr
Average Fraction of Improvement in Electric Energy Intensities from:			
Energy Efficiency Improvement	93%	90%	
Solar Thermal Energy (hot water/space heat/space cooling)	5%	7%	
On-site Solar PV	1%	2%	
On-site Biomass/Biogas/Landfill Gas Energy Use	1%	1%	
Green Power Purchase (from off-site, beyond electricity supply RPS)	0%	0%	
All "placeholder" assumptions, except on-site biomass/biogas/landfill gas energy use calculated so that values sum to 100%.			
Average Fraction of Improvement in Gas Energy Intensities from:			
Energy Efficiency Improvement	95%	93%	
Solar Thermal Energy (hot water/space heat/space cooling)	5%	7%	
On-site Solar PV	0%	0%	
On-site Biomass/Biogas/Landfill Gas Energy Use	0%	0%	
Green Power Purchase (from off-site, beyond electricity supply RPS)	0%	0%	
All "placeholder" assumptions, except on-site biomass/biogas/landfill gas energy use calculated so that values sum to 100%.			
Adjustment for Inclusion of Rennovated Commercial Space as Well as New Under New Code Requirements.		1.30	
Currently set at 1.3 so that about 0.3 unit of renovated space is included per unit of new space (initial assumption). Based on regional and national studies--see ***Note 4****. It may be useful to obtain further NC-specfic information regarding this value if available in the future.*			
Adjustment of Energy Use per Unit Floor Area for State/State-funded Buildings Relative to Average Commercial Building in North Carolina	1.00	1.00	
Placeholder assumption.			
Adjustment to Include Floor Area of New/Renovated space occupied by state and local government agencies in leased buildings.	1.10	1.10	
Placeholder assumption. Data available from the North Carolina State Property Office (http://www.ncspo.com/fis/) suggests that there are well over 100 state-leased buildings (and spaces in buildings), but in many cases information on the floorspace of those leases is not available. Likewise, data on the fraction of municipal and county government-leased floorspace was not readily available, thus 10 percent is used as an overall figure-of-merit until better data are available.			
Fraction of New/Renovated Commercial Space in Government Buildings		17.8%	
This estimate includes state-owned buildings plus local government buildings, including schools. Estimate starts with a compilation of the floorspace of state-owned buildings in North Carolina, and applies the ratio of state-owned buildings to total non-federal government-owned commercial-sector floorspace in the South Atlantic region, as described in CBECS 2003 data (see "NC_Activities_Est" worksheet in this workbook), pending receipt of NC-specific data for non-state government-owned building area (***see Note 5****). This estimate assumes that the ratio of floorspace in new government buildings to floorspace in all new commercial buildings is similar to the ratio of floorspace in existing government buildings to floorspace in all existing commercial buildings.*			
Adjustment to Exclude Floor Area of New/Renovated State/State-funded buildings not included in option.	1.00	1.00	
Placeholder assumption. Reduce below 1.0 if, for example, the option is designed to exclude small or special-use buildings.			
Implied Annual Square Feet New Building Space Covered by Policy (million)	-	9.34	
Implied Cumulative Impacts of Option, New Government Space (Electricity savings)			
Energy Efficiency Improvement	-	170.00	GWh
Solar Thermal Energy (hot water/space heat/space cooling)	-	11.61	GWh
On-site Solar PV	-	3.01	GWh
On-site Biomass/Biogas/Landfill Gas Energy Use	-	1.86	GWh
Green Power Purchase (from off-site, beyond electricity supply RPS)	-	-	GWh

Implied Cumulative Impacts of Option, New Government Space (Natural Gas savings)			
Energy Efficiency Improvement	-	167.29	GBtu/yr
Solar Thermal Energy (hot water/space heat/space cooling)	-	11.11	GBtu/yr
On-site Solar PV	-	-	GBtu/yr
On-site Biomass/Biogas/Landfill Gas Energy Use	-	(0.00)	GBtu/yr
Green Power Purchase (from off-site, beyond electricity supply RPS)	-	-	GBtu/yr
Implied Cumulative Impacts of Option, Existing Government Space (Electricity savings)			
Energy Efficiency Improvement	-	1,112.60	GWh
Solar Thermal Energy (hot water/space heat/space cooling)	-	86.54	GWh
On-site Solar PV	-	24.72	GWh
On-site Biomass/Biogas/Landfill Gas Energy Use	-	12.36	GWh
Green Power Purchase (from off-site, beyond electricity supply RPS)	-	-	GWh
Implied Cumulative Impacts of Option, Existing Government Space (Natural Gas savings)			
Energy Efficiency Improvement	-	1,120.21	GBtu/yr
Solar Thermal Energy (hot water/space heat/space cooling)	-	84.32	GBtu/yr
On-site Solar PV	-	-	GBtu/yr
On-site Biomass/Biogas/Landfill Gas Energy Use	-	(0.00)	GBtu/yr
Green Power Purchase (from off-site, beyond electricity supply RPS)	-	-	GBtu/yr

Additional Inputs to/Intermediate Results of Costs

Estimated annual levelized cost of solar hot water per unit output	20.77	18.70	$/MMBtu
Based on inputs to/results of solar hot water heating analysis included in other RCI options.			
Adjustment to solar thermal costs for inclusion of space heat/cooling measures	1.00	1.00	
Placeholder assumption--Value of 1.0 implies that solar space heat and cooling will cost the same per unit output as solar water heating.			
Implied Per Unit Cost Electricity Avoided by Solar WH/SH/Cooling	65.91	59.32	$/MWh
Implied Per Unit Cost Natural Gas Avoided by Solar WH/SH/Cooling	14.54	13.09	$/MMBtu
Assumes delivered solar WH/SH/Cooling replaces electric with EF of 0.93, gas with EF of 0.70 (and therefore one MMBtu of delivered solar heat is the equivalent of more than one MMBtu of each fuel).			
Estimated annual levelized cost of on-site Solar PV	223	129	$/MWh
Based on inputs to/results of solar PV analysis included in RCI-10.			
Fuel Cost for On-site Biomass/Biogas/Landfill Gas Energy Use		2.38	$/MMBtu
Based on costs for Biomass fuel, which will likely dominate this category of fuel inputs. See "Common Assumptions" worksheet in this workbook. If significantly processed biomass fuels (such as pelletized fuels) are required, this cost may need to be increased.			
Relative Efficiency of On-site Biomass/Biogas/Landfill Gas displacing electricity		0.75	
Placeholder assumption.			
Factor to reflect probable higher costs of on-site Biomass/Biogas/Landfill Gas Equipment Relative to Electric Equipment		2.00	
Placeholder assumption--In most cases, heating/water heating equipment designed to use biomass-derived fuels will be more expensive than equipment designed to use electricity. This factor loads these incremental capital costs into estimated fuel costs.			
Implied Per Unit Cost Electricity Avoided by Biomass/Biogas/Landfill Gas	21.59	21.59	$/MWh
Incremental Cost for Green Power Purchase (from off-site, beyond supply RPS)	25.00	16.71	$/MWh
Linked to RCI-9.			
Implied use of biomass/biogas/landfill gas by year	-	64.49	Billion Btu

Results	2010	2020	Units
Electricity (Conventional)			
Reduction in Electricity Sales: Residential (not included here)	0	0	GWh (sales)
Reduction in Electricity Sales: Commercial (government)	0	1,423	GWh (sales)
TOTAL Reduction in Electricity Sales	0	1,423	GWh (sales)
Reduction in Generation Requirements	0	1,507	GWh (generation)
GHG Emission Savings	**0.00**	**1.07**	$MMtCO_2e$
Economic Analysis			
Net Present Value (2007-2020)		**-$77**	$million
Cumulative Emissions Reductions (2007-2020)		6.0	$MMtCO_2e$
Cost-Effectiveness		**-$12.89**	$/tCO_2e$
Natural Gas			
Reduction in Gas Use	0	1,383	Billion BTU
GHG Emission Savings	**0.00**	**0.07**	$MMtCO_2e$
Economic Analysis			
Net Present Value (2007-2020)		**-$10**	$million
Cumulative Emissions Reductions (2007-2020)		0.4	$MMtCO_2e$
Cost-Effectiveness		**-$27.18**	$/tCO_2e$
Biomass/Biogas/Landfill Gas Fuel Use			
Added GHG Emissions from Biomass Fuels Use	**0.00000**	**0.00018**	$MMtCO_2e$
Cumulative added Emissions from Biomass Fuels (2007-2020)		0.0009	$MMtCO_2e$

Summary Results for RCI-3	2010	2020	Units
Total for Policy (Natural gas and electricity less biomass)			
GHG Emission Savings	**0.00**	**1.15**	$MMtCO_2e$
Net Present Value (2007-2020)		**-$87.7**	$million
Cumulative Emissions Reductions (2007-2020)		6.4	$MMtCO_2e$
Cost-Effectiveness		**-$13.74**	$/tCO_2e$

NOTES AND DATA FROM SOURCES

Note 1:

From The Energy Efficiency Task Force Report to the Clean and Diversified Energy Advisory Committee of the Western Governors Association.
The Potential for More Efficient Electricity Use in the Western United States, January, 2006. This report is referred to here as the "WGA CDEAC EE report" and can be found at:
http://www.westgov.org/wga/initiatives/cdeac/Energy%20Efficiency-full.pdf.

In the WGA CDEAC EE report, Building Code improvements were effectively modeled in two steps. The first, assumed to be effectively a baseline action, in the context of this study, but called the "Current Activities" case, brought codes up to recent IIEC levels as follows:

> "In particular, we assume adoption of a recent version of the IECC leads to 5% electricity savings on average in states in colder or moderate climates, and 13% savings in homes in very hot climates (AZ, TX, and NV). Regarding commercial buildings, we assume adoption of the code leads to 10% electricity savings in moderate and colder states, and 15% savings in very hot states (Kinney, Geller, and Ruzzin 2003). For California, we used estimates of the electricity savings from building code upgrades adopted in 2001 and 2005 (Mahone, et al. 2005). These savings levels are prior to the adjustment for savings realization mentioned in Table V.1" [Quote from footnote, page 40]

The second increase, to the CDEAC "Best Practices" Scenario, included the following improvements:

> "This [Best Practices] scenario assumes that the International Energy Conservation Code, 2004 version, is adopted in 2007 in all states except California, as California has its own more stringent standard. It is assumed that state and/or local building energy codes are upgraded in 2011 (3% improvement) and in 2015 (additional 6% improvement). This scenario also assumes that compliance and enforcement are improved and that a 90% savings realization rate is achieved. Finally, we assume that California's current building energy codes will be upgraded in 2009 (3%), 2013 (6%) and 2017 (3%)." [Quote from page 41]

The CDEAC report provides a cost of saved energy (electricity) of 4.74 cents/kWh, in 2005 dollars, based on an average 7-year payback for code improvements (page 42).

Note 2:

The Southwest Energy Efficiency Project's (SWEEP) Report
Increasing Energy Efficiency in New Buildings in the Southwest: Energy Codes and Best Practices
includes state-by-state estimates of the potential savings from two scenarios of building code and "beyond code" efficiency improvements.

For New Mexico, as an example, the cost and energy savings figures shown in the SWEEP report suggest the following for the "Strong Improvement" scenario:

	2010	2020	
Costs (million)	35.1	44	Constant 2003 dollars
TBtu Saved	3.1	7.5	Electric plus Gas
Implied $/MMBtu	11.32	5.87	
Implied $/MWh	38.63	20.02	

Note 3:
Based on results from Table B.5 of the 2003 Commercial Buildings Energy Consumption Survey, Detailed Tables dated October 2006 and published by the US Department of Energy's Energy Information Administration, and available as http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/pdf2003/alltables.pdf, as described in "NC_Activities_Est" worksheet in this workbook.

Following data on electricity sales in North Carolina as of 2005 as described in "Utility_Sales" worksheet in this workbook. Downloaded from http://www.eia.doe.gov/cneaf/electricity/epa/epa_sprdshts.html (file sales_revenue.xls)

	MWh	Fraction of Total
Residential	54,072,734	42%
Commercial	44,161,328	34%
Industrial	30,101,279	23%
Total	128,335,341	100%

For natural gas consumpation, consumption data from the USDOE EIA downloaded from http://www.eia.doe.gov/oil_gas/natural_gas/applications/eia176query.html are are follows:
(See "EIA_NG_Data" worksheet in this workbook for raw EIA data)

	Sales (Million Cubic Feet of Natural Gas)			
	Residential	Commercial	Industrial	Total
2005	63,865	41,776	22,956	128,597
Fraction of 2005 Total	50%	32%	18%	100%

Note 4:
The estimate of 0.3 unit of renovated space per unit of new construction in the commercial sector is a rough assumption.
It is likely that the ratio of commercial space undergoing major renovation to new commerial space will fluctuate year by year. A review of CBECS data (Table B5, see reference in Note 2 for RCI-7) suggests that in the South Atlantic Region renovated space (space renovated since 1980) is about one-third of new commercial building space constructed since 1980.
Some of these renovations likely would not affect building energy performance, but CBECS data suggest that a substantial portion of renovated space involves changes to outside walls and roofs, additions or annexes, or changes to HVAC systems, all of which would seem to be markets for RCI-3.
It is clear that the renovation market represents a substantial opportunity for improving energy efficiency through the type of "beyond code" changes included in this option.
Looking at the few easily accessible studies nationwide, a study of the non-residential renovation market in California (Remodeling and Renovation of Nonresidential Buildings in California, by Donald R. Dohrmann, John H. Reed, Sylvia Bender, Catherine Chappell, and Pierre Landry, available as http://www.energy.ca.gov/papers/2002-08-18_aceee_presentations/PANEL-10_DOHRMANN.PDF) suggests that by 1999 the value of renovations and additions to non-residential space was similar to that in new non-residential space, based on building permit data. As both California and North Carolina include a significant fraction of older buildings in their building stocks, the analogy with California may be reasonable for North Carolina. A study for a Texas building code report, however (see http://www.pnl.gov/main/publications/external/technical_reports/PNNL-15356.pdf) referenced the California report, but concluded that a more appropriate "conservative" value was approximately 20 percent as a long-term national average.

Note 5:
The following data were provided by Leonard Hoey of the NC State Energy Office, and reflect "gross square feet" of building area "as reported by the State Property Office". North Carolina-specific data on building area of non-State government buildings (including public schools and local/county government agencies, for example) are not yet available.

Date	Gross Square Feet
2002	93,988,942
2003	95,414,322
2004	96,159,042
2005	100,646,539
2006	105,668,142

The 2006 figure shown above for State buildings, however, can be used along with regional data from CBECS for the South Atlantic region (see "NC_Activities_Est" worksheet in this workbook) to estimate total government building area (state and non-state) as follows:

Fraction of total non-federal government buildings in the South Atlantic region that are state buildings (from CBECS, as of 2003):	25.9%
Implied year 2006 total area of non-federal government buildings in NC (million square feet):	408

Estimate of Mitigation Option Costs and Benefits for North Carolina RCI GHG Analysis

RCI-4 Market Transformation and Technology Development Programs

Date Last Modified: 2/12/2007 D. Von Hippel/A Bailie

Key Data and Assumptions	2010	2020/all	Units
First Year Results Accrue		2012	
Savings from Alliance Programs			
Reduction in overall electricity use		0.2%	per year

Based on WGA (2005) - The Potential for More Efficient Electricity Use in the Western United States, Energy Efficiency Task Force Report to the Clean and Diversified Energy Advisory Committee of the Western Governors' Association. This study estimates that market transformation programs could achieve reductions in electricity consumption of about 0.2% per year, based on programs and experience similar to those of the Northwest Energy Efficiency Alliance. See NEEA 2004 Annual Report. www.nwalliance.org/resources/documents/A_2004AR.pdf. These savings are in addition to those achieved through building energy codes and utility DSM programs (no double counting).

For North Carolina, a key implementation strategy could be support for and expansion of the Southeast Energy Efficiency Alliance, www.seea.us, which was initiated in 2006 as a subsidiary to the Alliance to Save Energy.

Assumed Cost of Market Transformation Program Savings		$12	$/MWh

From WGA EE Task Force study (2005), which cites the Retrospective Analysis of the Northwest Energy Efficiency Alliance (Violette, Ozog, and Cooney, 2003).

Avoided Electricity Cost		$57	$/MWh

See common assumptions.

Other Data, Assumptions, Calculations	2010	2020/all	Units
Total Statewide Electricity Sales	134,876	159,498	**GWh**

Results	2010	2020	Units
Total Net GHG Emission Savings	0.0	2.0	$MMtCO_2e$
Net Present Value (2007-2020)		-$339	$million
Cumulative Emissions Reductions (2007-2020)		10.5	$MMtCO_2e$
Cost-Effectiveness		-$32	$/tCO_2e$
TOTAL Reduction in Electricity Sales	0	2,687	GWh (sales)
as share of projected sales	0.0%	1.7%	
Reduction in Generation Requirements	0	2,846	GWh (generation)

Estimate of Mitigation Option Costs and Benefits for North Carolina RCI GHG Analysis

RCI-5 **Improved Appliance and Equipment Efficiency Standards**

Date Last Modified:	*2/12/2007 D. Von Hippel/A Bailie*

Key Data and Assumptions	2010	2020/all	Units
First Year Results Accrue		**2012**	
Projected Electricity Savings from 15 Proposed Standards (in 2020)		**1,297**	GWh
Projected Natural Gas Savings from 15 Proposed Standards (in 2020)		**363**	million ft^3
Projected NPV Savings (to 2030, $2005)		**$943**	million

The above findings are drawn from ASAP and ACEEE, 2006. "Leading the Way: Continued Opportunities for New State Appliance and Equipment Efficiency Standards", http://www.standardsasap.org/stateops.htm. The NPV results were derived using a 5% discount rate, and electricity prices of 8.7c/kWh ($13.6/thousand cubic ft gas) residential and 6.9c/kWh ($11.7/thousand cubic ft gas) commercial. The resulting NPV savings are thus slightly higher than would be obtained using our avoided delivered electricity and gas cost estimates.

Adjustment factor for NPV timespan		**0.527**	
This is the ratio of NPV values from 2007-2020 vs. 2005-2030 for a constant net benefit starting in 2012.			
Adjustment factor for different electricity and gas avoided costs		**0.677**	
Simple adjustment assumes the benefits are largely on the electricity side, and equals the ratio of incremental cost savings per MWh using the following values (appliance standards cost from WGA 2005; ASAP/ACEEE assumes average of res and comm):			
Average cost of efficiency improvements via standards		**$12**	$/MWh
Average cost of electricity in ASAP/ACEEE study		**$78**	$/MWh
Avoided cost used here (res/comm avg)		**$57**	$/MWh

Other Data, Assumptions, Calculations	2010	2020/all	Units
National Savings	14	52	TWh
ASAP/ACEEE, 2006. Assume here same ratio of 2010 to 2020 savings in NC for electricity. All gas-saving standards come into force in 2012, so no 2010 gas savings			

Results	2010	2020	Units
Electricity			
Reduction in Electricity Sales	0	1,297	GWh (sale:
Reduction in Generation Requirements	0	1,374	GWh (gene
GHG Emission Savings	**0.00**	**0.98**	$MMtCO_2e$
Cumulative Emissions Reductions (2007-2020)		5.2	$MMtCO_2e$
Natural Gas			
Reduction in Gas Use	0	374	Billion BTU
GHG Emission Savings	**0.00**	**0.02**	$MMtCO_2e$
Cumulative Emissions Reductions (2007-2020)		0.10	$MMtCO_2e$
Total for Option (Natural gas and electricity)			
GHG Emission Savings	**0.00**	**1.00**	$MMtCO_2e$
Net Present Value (2007-2020)		**-$336**	$million
Cumulative Emissions Reductions (2007-2020)		5.3	$MMtCO_2e$
Cost-Effectiveness		**-$63**	$/tCO_2e$

Estimate of Mitigation Option Costs and Benefits for North Carolina RCI GHG Analysis

RCI-6 **Building Energy Codes**

Date Last Modified: *5/31/2007 D. Von Hippel/A Bailie*

Key Data and Assumptions	2010	2020/all	Units
First Year Results Accrue		2008	
Electricity	2010	2020/all	Units
Levelized Cost of Electricity Savings		$35.0	$/MWh
Based on 7 year payback as estimated in WGA CDEAC EE Report. (See Note 1, below.)			
Levelized Cost of Natural Gas Savings		$5.1	$/MMBtu
Based on 7 year payback as estimated in WGA CDEAC EE Report. (See Note 1, below.)			
Avoided Electricity Cost		$57	$/MWh
Weighted average over total 2007-2020 electricity savings for this policy in each sector. See common assumptions ("Common Factors" worksheet in this workbook).			
Avoided Natural Gas Cost		$8	$/MMBtu
See common assumptions ("Common Factors" worksheet in this workbook)			

Other Data, Assumptions, Calculations	2010	2020/all	Units
Adjustment for Inclusion of Rennovated Residential Space as Well as New Under New Code Requirements. *(Currently set at 1.0 so that no rennovated residential space is included–need to ask an NC building professional for an opinion on this value.)*		1.00	
Adjustment for Inclusion of Rennovated Commercial Space as Well as New Under New Code Requirements. *Currently set at 1.3 so that about 0.3 unit of renovated space is included per unit of new space (initial assumption). Based on regional and national studies–see Note 3. It may be useful to obtain further NC-specfic information regarding this value if available in the future.*		1.30	
Adjustment for Inclusion of New Industrial Space in Estimated Savings due to New Code Requirements (applied to total residential plus commercial savings) (See ***Note 3***)		104.4%	
Ratio of Electricity Savings to Gas Savings: Residential Sector	730	730	GWh/TBtu
Ratio of Electricity Savings to Gas Savings: Commercial Sector	943	943	GWh/TBtu
Estimated based on relative NC usage of electricity and gas by sector in 2004. Alternative factors could be derived from other sources to account for differences in expected levels of electricity and natural gas savings.			

Results	2010	2020	Units
Electricity			
Recent Actions not included in forecast -- assume all recent savings are included in forecast			
Reduction in Electricity Sales: Residential	0	0	GWh (sales)
Red		0	GWh (sales)
Red		0	GWh (sales)
TO		0	GWh (sales)
Reduction in Generation Requirements	0	0	GWh (generati
GHG Emission Savings	**0.00**	**0.00**	$MMtCO_2e$

These rows are not used currently but are retained in case there is need to estimate savings from current activities

Savings due to Additional Effort in RCI-6			
Reduction in Electricity Sales: Residential	254	2,395	GWh (sales)
Reduction in Electricity Sales: Commercial	199	1,731	GWh (sales)
Reduction in Electricity Sales: Industrial	20	182	GWh (sales)
TOTAL Reduction in Electricity Sales	473	4,307	GWh (sales)
Reduction in Generation Requirements	504	4,563	GWh (generati
GHG Emission Savings	**0.44**	**3.25**	$MMtCO_2e$

Economic Analysis (for Electricity Savings due to Additional Effort in RCI-6)		
Net Present Value (2007-2020)	**-$342.6**	$million
Cumulative Emissions Reductions (2007-2020)	21.4	$MMtCO_2e$
Cost-Effectiveness	**-$16.00**	$/tCO_2e$

Natural Gas

Recent Actions not included in forecast

Reduction in Gas Sales: Residential	0	0	Billion BTU
Reducti		0	Billion BTU
Reducti		0	Billion BTU
Reducti		0	Billion BTU
GHG Emission Savings	0	0.00	$MMtCO_2e$

These rows are not used currently but are retained in case there is need to estimate savings from current activities

Savings due to Additional Effort in RCI-6

Reduction in Gas Sales: Residential	348	3,280	Billion BTU
Reduction in Gas Sales: Commercial	211	1,836	Billion BTU
Reduction in Gas Sales: Industrial	21	193	Billion BTU
Reduction in Gas Use	581	5,309	Billion BTU
GHG Emission Savings	0.03	0.28	$MMtCO_2e$

Economic Analysis (for Savings due to Additional Effort in RCI-6)

Net Present Value (2007-2020)	**-$57.9**	$million
Cumulative Emissions Reductions (2007-2020)	1.7	$MMtCO_2e$
Cost-Effectiveness	**-$34.40**	$/tCO_2e$

Summary Results for RCI-6	2010	2020	Units
Recent Actions Not Included in Forecast (Current/planned building code changes)			
Electric GHG Emission Savings	**0.00**	**0.00**	$MMtCO_2e$
Gas GHG Emission Savings	**0.00**	**0.00**	$MMtCO_2e$
Total GHG Emission Savings	**0.00**	**0.00**	$MMtCO_2e$
Total for Option (Natural gas and electricity)			
GHG Emission Savings	**0.47**	**3.53**	$MMtCO_2e$
Net Present Value (2007-2020)		**-$400**	$million
Cumulative Emissions Reductions (2007-2020)		23.1	$MMtCO_2e$
Cost-Effectiveness		**-$17.34**	$/tCO_2e$

NOTES AND DATA FROM SOURCES

Note on Overall Approach to Analysis

The analysis for this option is based on structure used by the Building Codes Assistance Project (see http://www.bcap-energy.org). The analysis uses existing energy consumption and parameters to account for savings due to energy used for space conditioning in different climates and the estimated impact of building codes.

From Mitigation Option Description, the goals of the option are

- **Goals:**
  - Enforce existing building energy codes by 2008.
  - Establish a new energy code by 2010 that requires new NC residences and commercial/industrial buildings to be 20% more efficient than buildings meeting current national building energy codes, and assure that the new code is enforced.

This analysis estimates the savings from full enforcement of the existing NC building code (according to energycodes.gov, "The NC Building Code Council has adopted the 2003 IECC with NC amendments effective July 1, 2006. The amendments include adoption of ASHRAE 90.1-2004. Chapter 11 of the 2003 IRC has also been adopted and includes NC amendments; the effective date for the new 2006 NC Residential Code has been delayed until July 1, 2007." IECC is the International Energy Conservation Code

For 2008, this analysis assumes that the 2006 code (based on IECC 2003) achieves energy savings of

residential	3%	, eg standard practice is equivalent to about 1998 IECC levels
commercial	6%	, eg standard practice is equivalent to about ASHRAE 2001 levels

This assumption is based on notes provided by the Building Codes Assistance Project
(see notes on cells in column T and V in table below)

For enforcement rates, the analysis assumes:

	rate of energy code enforcement currently, before mitigation action (no source for this
50%	estimate, needs review by TWG)
95%	rate of energy code enforcement with this mitigation option in place

These are rough estimates and more appropriate values for North Carolina are welcomed.

For 2010, this analysis assumes that the current national building code will be approximately IECC 2003, or the equivalent of NC's 2006 code. Thus the options will achieve

20%	savings, relative to 2008 improvements

Annual energy savings are estimated using the table below are result in estimated savings of

2008 (code enforcement)

residential	0.019 TWh
Commercial	0.017 TWh

2010 (20% energy savings)

residential	0.206 TWh
Commercial	0.113 TWh

The above values are based on energy and households in 2005, these values are adjusted to provide future savings based on increased number of houses. See below

	RESIDENTIAL								
	STATE	TOTAL HOUSING UNITS	NEW HOUSING UNITS AUTHORIZED BY PERMIT (PRIVATELY OWNED)		Ratio - new units / existing units	TOTAL ELECTRICITY ENERGY USE (TWh) 2005	Estimated Electric energy use, new residential units (TWh)	Electric space conditioning multiplier (see "HVAC and Fuel Mix" worksheet)	energy use for space conditioning - new res buildings (TWh)
full enforcement of 2006 IECC									
	NC	4,022,589	82035		0.0204	54.1	1.10	26.0%	0.2870
20% improvement									
	NC						1.0841		

Incremental annual energy savings		2007	2008	2009	2010	2011	2012	2013
Residential	TWh	0	0.019	0.019	0.216	0.206	0.209	0.212
Commercial	TWh	0	0.017	0.017	0.119	0.113	0.115	0.117
growth factor, population based relative to population growth from 2005 (energy savings based on 2005 data)			1.02	1.03	1.05	1.00	1.01	1.03

North Carolina	New housing units	82,035	2005

	COMMERCIAL						ENERGY SAVINGS POTENTIAL (TWh)						Code in 2006	
	Ratio - new/existing	TOTAL ELECTRICITY ENERGY USE (TWh) 2005	Energy Intensity Correction Factor by Climate Zone and Vintage	Percentage of electric energy for Heating, Cooling, and Lighting	Commercial electric energy use for Heating, Cooling, & Lighting for new buildings (TWh)	STATE	Residential Savings Multiplier reflecting change from 2006 state code to 2004/2006 IECC.	Energy Savings Potential Residential New Construction	Energy Savings Potential Replacement Window	Commercial Savings Multiplier reflecting change from 2006 state code to ASHRAE 90.1-2004.	Energy Savings Potential Commercial New Construction	STATE	Residential	Commercial
	0.0216	44.2	1.20	0.54	0.61	NC	0.030	0.015	0.004	0.060	0.017	NC	2003 IECC	2003 IECC
					0.60	NC	0.200	0.206	N/A	0.200	0.113	NC	2003 IECC	2003 IECC

2014	2015	2016	2017	2018	2019	2020
0.215	0.218	0.210	0.213	0.216	0.219	0.222
0.118	0.120	0.116	0.117	0.119	0.121	0.122
1.04	1.06	1.02	1.04	1.05	1.06	1.08

The following parameters are used to adjust the total electricity consumption in the residential sector to electricity use for space conditioning (data from the Residential Energy Consumption Survey (EIA)). A parameter for the commercial sector is used to adjust estimates of commercial electric energy use for Heating, Cooling, & Lighting for new buildings for climate.

July 2002-June 2003 State Heating Degree Days (HDD)					
			Residential		Commercial
	HDD65	CDD65	RECS Climate Zone	% electric space conditioning	
NC	3222	1558	4	26.0%	1.1986

Sources: http://lwf.ncdc.noaa.gov/oa/documentlibrary/hcs/hdd.200507-200607.pdf
http://lwf.ncdc.noaa.gov/oa/documentlibrary/hcs/cdd.200501-200607.pdf

Energy Intensity Correction Factor by Climate Zone	
All Buildings	1.1538
>7000 HDD	1.1309
5500-7000	1.2408
4000-5499	1.0297
<4000	1.1986
>2000 CDD & <4000 HDD	1.1953

Household Electricity End Use					
	Climate Zone				
	<2000 CDD				>2000 CDD and <4000 HDD
	>7000 HDD	5500-7000 HDD	4000-5499 HDD	<4000 HDD	
	Quadrillion Btus				
Climate Category	**1**	**2**	**3**	**4**	**5**
Space-Heating	0.03	0.08	0.12	0.08	0.09
Electric AC (central & room)	0.02	0.08	0.11	0.11	0.30
Water Heating	0.04	0.06	0.08	0.07	0.11
Refrigerators	0.04	0.13	0.11	0.10	0.15
Other Appliance & Lighting	0.18	0.52	0.43	0.37	0.48
TOTAL	0.31	0.87	0.85	0.73	1.13
Percent Electric Space Conditioning	**16.1%**	**18.4%**	**27.1%**	**26.0%**	**34.5%**
Source: 2001 RECS (http://www.eia.doe.gov/emeu/recs/recs2001/detailcetbls.html#space)					

Additional Notes

Note 1:

From The Energy Efficiency Task Force Report to the Clean and Diversified Energy Advisory Committee of the Western Governors Association.
The Potential for More Efficient Electricity Use in the Western United States, January, 2006. This report is referred to here as the "WGA CDEAC EE report" and can be found at:
http://www.westgov.org/wga/initiatives/cdeac/Energy%20Efficiency-full.pdf.
The CDEAC report provides a cost of saved energy (electricity) based on an average 7-year payback for code improvements (page 42).

For North Carolina, the equivalent cost is estimated as follows for electricity and natural gas

payback	7	years, from CDEAC report	
lifespan	25	years, conservative assumption	
elec price	**70.40**	$/MWh	see common factors
NG price	**10.18**	$/MMBTU	see common factors

Electricity levelized cost	$34.965	$/MWh
Natural Gas levelized cost	$5.054	$/MMBTU

Note 2:

Based on results from Table 5.8 of the 2002 Energy Consumptions by Manufacturers--Data Tables published by the US Department of Energy's Energy Information Administration, and available as http://www.eia.doe.gov/emeu/mecs/mecs2002/data02/pdf/table5.8_02.pdf, approximately 14% of industrial electricity use in the South Census region is used for HVAC, lighting, and "other facility support", with of natural gas used for HVAC and "other facility support".

In North Carolina, as of 2005, total electricity use by sector was as follows (from Retail Sales of Electricity by State by Sector by Provider, downloaded from http://www.eia.doe.gov/cneaf/electricity/epa/epa_sprdshts.html (file sales_revenue.xls)

	MWh	Fraction of Total
Residential	54,072,734	42%
Commercial	44,161,328	34%
Industrial	30,101,279	23%
Total	128,335,341	100%

Thus industrial use of electricity for non-process uses in North Carolina may be roughly 4.4% of total Residential and Commercial electricity use. This figure is used as an initial rule of thumb in estimating the contribution of savings from this policy from industrial sector measures.

Note 3:

The estimate of 0.3 unit of renovated space per unit of new construction in the commercial sector is a rough assumption.
It is likely that the ratio of commercial space undergoing major renovation to new commerial space will fluctuate year by year. A review of CBECS data (Table B5, see reference in Note 2 for RCI-7) suggests that in the South Atlantic Region renovated space (space renovated since 1980) is about one-third of new commercial building space constructed since 1980.
Some of these renovations likely would not affect building energy performance, but CBECS data suggest that a substantial portion of renovated space involves changes to outside walls and roofs, additions or annexes, or changes to HVAC systems, all of which would seem to be markets for RCI-6.
It is clear that the renovation market represents a substantial opportunity for improving energy efficiency through code changes.
Looking at the few easily accessible studies nationwide, a study of the non-residential renovation market in California (Remodeling and Renovation of Nonresidential Buildings in California, by Donald R. Dohrmann, John H. Reed, Sylvia Bender, Catherine Chappell, and Pierre Landry, available as http://www.energy.ca.gov/papers/2002-08-18_aceee_presentations/PANEL-10_DOHRMANN.PDF) suggests that by 1999 the value of renovations and additions to non-residential space was similar to that in new non-residential space, based on building permit data. As both California and North Carolina include a significant fraction of older buildings in their building stocks, the analogy with California may be reasonable for North Carolina. A study for a Texas building code report, however (see http://www.pnl.gov/main/publications/external/technical_reports/PNNL-15356.pdf) referenced the California report, but concluded that a more appropriate "conservative" value was approximately 20 percent as a long-term national average.

Note 4:

Calculated based on July-2004 to July-2005 estimate of total housing units in North Carolina from http://www.census.gov/popest/housing/HU-EST2005.html (see "2005 Total Housing Units" worksheet in this workbook). Since this figure implicitly nets out demolitions, it may somewhat undercount new units. The source: http://www.census.gov/const/C40/Table2/t2yu200512.txt provides an estimate of 100,220 "New Privately Owned Housing Units Authorized", which may be somewhat of an over-estimate for total new housing units in North Carolina, as it would presumably include some permitted units not ultimately built. We use the former estimate at present as the basis for calculation of future growth in housing units.

Estimate of Mitigation Option Costs and Benefits for North Carolina RCI GHG Analysis

RCI-7 **"Beyond Code" Building Design Incentives and Targets, Incorporating Local Building Materials and Advanced Construction**

Date Last Modified:	*5/31/2007 D. Von Hippel/A Bailie*

Key Data and Assumptions	2010	2020/all	Units
First Year Results Accrue		2008	
Based on goal set in Mitigation Option Design for RCI-7 (version dated 10/27/06) that reads "Ramp up program starting in 2007 to full effectiveness by 2012, except where noted otherwise".			
Electricity	2010	2020/all	Units
Levelized Cost of Electricity Savings		$35	$/MWh
As estimated for RCI-6. Based on 7-year payback as estimated in WGA CDEAC EE Report. (See Note 1 in RCI-6.)			
Levelized Cost of Natural Gas Savings		$5.1	$/MMBtu
As estimated for RCI-6. Based on 7-year payback as estimated in WGA CDEAC EE Report. (See Note 1 in RCI-6.)			
Avoided Electricity Cost		$57	$/MWh
See "AvCost" and "Common Factors" worksheets in this workbook.			
Avoided Natural Gas Cost		$8.0	$/MMBtu
See "NG prices aeo2006" and "Common Factors" worksheets in this workbook.			

Other Data, Assumptions, Calculations	2010	2020/all	Units
Inputs to/Intermediate Results of Calculation of Electricity and Gas Savings			
Average Electricity and Gas Savings Beyond Code Levels (new commercial and residential buildings)	30%	32%	
The description for this option currently includes the following: "5% of new residential buildings and 2% of new commercial buildings annually to go to 'beyond code' energy use levels that improve energy performance over the average new building (that meets the upgraded building code) by 30%...and encourage significant examples throughout the state of various building types that use 50% or less energy than is supported by the existing building code. This is interpreted to mean that participating buildings will be on average 30 percent more efficient than code in 2010, and an estimated average of 32 percent more efficient than code (meaning about 10 percent of participating buildings use 50 percent less energy than code--the "examples" referred to above) in 2020.			
Note in particular that the level of savings shown here is beyond that already included in Option RCI-6, and thus already includes an improvement in efficiency relative to average current practice.			
Total Commercial Floorspace in North Carolina (million square feet)	2,427	2,780	
Estimated (see "NC_Activities_Est" worksheet in this workbook) based on USDOE EIA CBECS (comercial survey) data for the South Atlantic region, extrapolated using projected North Carolina population as a driver.			
Est. area of new commercial space per year based on (million square feet)	35.7	36.6	
Calculated based on annual floorspace estimates above.			
Total Residential Housing Units in North Carolina	4,358,500	5,210,875	
Assumes 2005 ratio of new homes to increase in population holds through 2020.			
Implied persons per housing units in North Carolina (for reference only)	2.15	2.06	
Estimated number of new residential units per year	86,082	88,377	
Calculated based on estimates above.			
Implied Average Electricity Consumption per Square Foot Commercial Space in North Carolina as of 2005 (see ***Note 2***)		19.59	kWh/yr
Implied Average Natural Gas Consumption per Square Foot Commercial Space in North Carolina as of 2005 (see ***Note 2***)		19.09	kBtu/yr
Implied Average Electricity Consumption per Housing Unit in North Carolina as of 2005 (see ***Note 2***)		13.72	MWh/yr
Implied Average Natural Gas Consumption per Housing Unit in North Carolina as of 2005 (see ***Note 2***)		16.69	MMBtu/yr

NEW BUILDINGS

Electricity Use per New/Renovated Commercial Sq. Ft. After RCI-6 Application *Reduces future per-unit electricity use based on savings from building code improvements (20 percent improvement by 2010) included in RCI-6.*	16.3	16.3	kWh/yr
Nat. Gas Use per New/Renovated Commercial Sq. Ft. After RCI-6 Application *Assumes the same pattern of code improvement as for electricity use, as described above.*	15.6	15.6	kBtu/yr
Implied Electricity Use per New/Renovated Commercial Square Foot After RCI-6 Application, Relative to Average in North Carolina as of 2005	83.0%	83.0%	
Implied Natural Gas Use per New/Renovated Commercial Square Foot After RCI-6 Application, Relative to Average in North Carolina as of 2005	81.5%	81.5%	
Electricity Use per New/Renovated Residential Unit After RCI-6 Application *Reduces future per-unit electricity use based on savings from building code improvements (20 percent improvement by 2010) included in RCI-6.*	11.2	11.2	MWh/yr
Natural Gas Use per New/Renovated Residential Unit After RCI-6 Application *Reduces future per-unit electricity use based on savings from building code improvements (20 percent improvement by 2010) included in RCI-6.*	13.3	13.3	kBtu/yr
Implied Electricity Use per New/Renovated Residential Unit After RCI-6 Application, Relative to Average in North Carolina as of 2005	81.7%	81.7%	
Implied Natural Gas Use per New/Renovated Residential Unit After RCI-6 Application, Relative to Average in North Carolina as of 2005	79.4%	79.4%	
Date program of improvement of new buildings fully "ramped up"		2012	
Fraction of new commercial buildings participating in program at full program level		2%	/yr
Fraction of new residential buildings participating in program at full program level		5%	/yr
Implied fraction of new commercial floorspace included in program *Note that government-sector floorspace is covered under RCI-3.*	1.2%	2.0%	/yr
Implied commercial floorspace included in program (million square feet)	0.428	0.732	/yr
Implied fraction of new residential units included in program	3.0%	5.0%	/yr
Implied new residential units included in program	2,582	4,419	/yr

EXISTING BUILDIINGS

Fraction of existing buildings (buildings existing as of 2005) upgraded under program		20%	
Date by which upgrading goal for existing buildings achieved *Placeholder estimate. The CCAG has requested the TWG to provide this target date.*		2015	
Date program of improvement of existing buildings fully "ramped up" *Assumed same as for new buildings.*		2012	
Fraction of existing buildings (buildings existing as of 2005) upgraded annually from 2012 on: *Adjust until the value at right ~ 0.2 (adjustment for lower penetration during ramp-in period)*	0.199998	3.33%	
Fraction of existing buildings (buildings existing as of 2005) upgraded annually:	2.0%	3.3%	
Electricity and Gas savings from upgrading existing commercial buildings		20%	
Electricity and Gas savings from upgrading existing residential buildings		15%	

CALCULATION OF SAVINGS

Required Elect/Gas Improvement in New Commercial and Residential Space After RCI-7 Policy Relative to Average in After Application of RCI-6 *Calculated based on inputs above.*	30.0%	32.0%	
Implied total electricity savings in new commercial buildings from RCI-7 *First-year savings--not cumulative.*	2.09	3.81	GWh/yr
Implied total gas savings in new commercial buildings from RCI-7 *First-year savings--not cumulative.*	2.00	3.65	GBtu/yr
Implied total electricity savings in new residential buildings from RCI-7 *First-year savings--not cumulative.*	8.69	15.85	GWh/yr
Implied total gas savings in new residential buildings from RCI-7 *First-year savings--not cumulative.*	10.27	18.74	GBtu/yr
Implied total electricity savings in existing commercial buildings from RCI-7 *First-year savings--not cumulative.*	177	294	GWh/yr
Implied total gas savings in existing commercial buildings from RCI-7 *First-year savings--not cumulative.*	172	287	GBtu/yr
Implied total electricity savings in existing residential buildings from RCI-7 *First-year savings--not cumulative.*	162	270	GWh/yr
Implied total gas savings in existing residential buildings from RCI-7 *First-year savings--not cumulative.*	197	329	GBtu/yr

Average Fraction of Improvement in Electric Energy Intensities from:

Energy Efficiency Improvement	93%	90%
Solar Thermal Energy (hot water/space heat/space cooling)	5%	7%
On-site Solar PV	1%	2%
On-site Biomass/Biogas/Landfill Gas Energy Use	1%	1%
Green Power Purchase (from off-site, beyond electricity supply RPS)	0%	0%

All "placeholder" assumptions, except on-site biomass/biogas/landfill gas energy use calculated so that values sum to 100%.

Average Fraction of Improvement in Gas Energy Intensities from:

Energy Efficiency Improvement	95%	93%
Solar Thermal Energy (hot water/space heat/space cooling)	5%	7%
On-site Solar PV	0%	0%
On-site Biomass/Biogas/Landfill Gas Energy Use	0%	0%
Green Power Purchase (from off-site, beyond electricity supply RPS)	0%	0%

All "placeholder" assumptions, except on-site biomass/biogas/landfill gas energy use calculated so that values sum to 100%.

Adjustment for Inclusion of Rennovated Commercial Space as Well as New Under Program. *Currently set at 1.3 so that about 0.3 unit of renovated space is included per unit of new space (initial assumption). Based on regional and national studies--see Note 3. It may be useful to obtain further NC-specfic information regarding this value if available in the future.*		1.30
Adjustment of Energy Use per Unit Floor Area for Commercial Buildings in Program Relative to Average Commercial Building in North Carolina *Placeholder assumption.*	1.00	1.00
Adjustment for Inclusion of Rennovated Residential Units as Well as New Under Program. *Currently set at 1.0 so that no renovated space is included per unit of new space (initial assumption). It may be useful to obtain further NC-specfic information regarding this value.*		1.00

Implied Cumulative Impacts of Option, New Commercial Space (Electricity savings)			
Energy Efficiency Improvement	5.4	47.0	GWh
Solar Thermal Energy (hot water/space heat/space cooling)	0.3	3.1	GWh
On-site Solar PV	0.1	0.8	GWh
On-site Biomass/Biogas/Landfill Gas Energy Use	0.1	0.5	GWh
Green Power Purchase (from off-site, beyond electricity supply RPS)	-	-	GWh
Implied Cumulative Impacts of Option, New Commercial Space (Natural Gas savings)			
Energy Efficiency Improvement	5.4	46.3	GBtu/yr
Solar Thermal Energy (hot water/space heat/space cooling)	0.3	3.0	GBtu/yr
On-site Solar PV	-	-	GBtu/yr
On-site Biomass/Biogas/Landfill Gas Energy Use	0.0	(0.0)	GBtu/yr
Green Power Purchase (from off-site, beyond electricity supply RPS)	-	-	GBtu/yr
Implied Cumulative Impacts of Option, Existing Commercial Space (Electricity savings)			
Energy Efficiency Improvement	328.6	2,963.4	GWh
Solar Thermal Energy (hot water/space heat/space cooling)	17.7	194.2	GWh
On-site Solar PV	3.5	48.5	GWh
On-site Biomass/Biogas/Landfill Gas Energy Use	3.5	32.4	GWh
Green Power Purchase (from off-site, beyond electricity supply RPS)	-	-	GWh
Implied Cumulative Impacts of Option, Existing Commercial Space (Natural Gas savings)			
Energy Efficiency Improvement	327.0	2,966.2	GBtu/yr
Solar Thermal Energy (hot water/space heat/space cooling)	17.2	189.2	GBtu/yr
On-site Solar PV	-	-	GBtu/yr
On-site Biomass/Biogas/Landfill Gas Energy Use	0.0	(0.0)	GBtu/yr
Green Power Purchase (from off-site, beyond electricity supply RPS)	-	-	GBtu/yr
Implied Cumulative Impacts of Option, New Residential Space (Electricity savings)			
Energy Efficiency Improvement	17.6	150.8	GWh
Solar Thermal Energy (hot water/space heat/space cooling)	0.9	9.9	GWh
On-site Solar PV	0.2	2.5	GWh
On-site Biomass/Biogas/Landfill Gas Energy Use	0.2	1.6	GWh
Green Power Purchase (from off-site, beyond electricity supply RPS)	-	-	GWh
Implied Cumulative Impacts of Option, New Residential Space (Natural Gas savings)			
Energy Efficiency Improvement	21.6	183.4	GBtu/yr
Solar Thermal Energy (hot water/space heat/space cooling)	1.1	11.7	GBtu/yr
On-site Solar PV	-	-	GBtu/yr
On-site Biomass/Biogas/Landfill Gas Energy Use	0.0	(0.0)	GBtu/yr
Green Power Purchase (from off-site, beyond electricity supply RPS)	-	-	GBtu/yr
Implied Cumulative Impacts of Option, Existing Residential Space (Electricity savings)			
Energy Efficiency Improvement	301.7	2,721.3	GWh
Solar Thermal Energy (hot water/space heat/space cooling)	16.2	178.3	GWh
On-site Solar PV	3.2	44.6	GWh
On-site Biomass/Biogas/Landfill Gas Energy Use	3.2	29.7	GWh
Green Power Purchase (from off-site, beyond electricity supply RPS)	-	-	GWh
Implied Cumulative Impacts of Option, Existing Residential Space (Natural Gas savings)			
Energy Efficiency Improvement	375.0	3,401.0	GBtu/yr
Solar Thermal Energy (hot water/space heat/space cooling)	19.7	216.9	GBtu/yr
On-site Solar PV	-	-	GBtu/yr
On-site Biomass/Biogas/Landfill Gas Energy Use	0.0	(0.0)	GBtu/yr
Green Power Purchase (from off-site, beyond electricity supply RPS)	-	-	GBtu/yr

Additional Inputs to/Intermediate Results of Costs

Estimated annual levelized cost of solar hot water per unit output	**20.77**	**18.70**	$/MMBtu
Based on inputs to/results of solar hot water heating analysis included in other RCI options.			
Adjustment to solar thermal costs for inclusion of space heat/cooling measures	1.00	1.00	
Placeholder assumption--Value of 1.0 implies that solar space heat and cooling will cost the same per unit output as solar water heating.			
Implied Per Unit Cost Electricity Avoided by Solar WH/SH/Cooling	**65.91**	**59.32**	$/MWh
Implied Per Unit Cost Natural Gas Avoided by Solar WH/SH/Cooling	**14.54**	**13.09**	$/MMBtu
Assumes delivered solar WH/SH/Cooling replaces electric with EF of 0.93, gas with EF of 0.70 (and therefore one MMBtu of delivered solar heat is the equivalent of more than one MMBtu of each fuel).			
Estimated annual levelized cost of on-site Solar PV	**223**	**129**	$/MWh
Based on inputs to/results of solar PV analysis included in 7B-RCI.			
Fuel Cost for On-site Biomass/Biogas/Landfill Gas Energy Use		2.38	$/MMBtu
Based on costs for Biomass fuel, which will likely dominate this category of fuel inputs. See "Common Assumptions" worksheet in this workbook. If significantly processed biomass fuels (such as pelletized fuels) are required, this cost may need to be i			
Relative Efficiency of On-site Biomass/Biogas/Landfill Gas displacing electricity		0.75	
Placeholder assumption.			
Factor to reflect probable higher costs of on-site Biomass/Biogas/Landfill Gas Equipment Relative to Electric Equipment		2.00	
Placeholder assumption--In most cases, heating/water heating equipment designed to use biomass-derived fuels will be more expensive than equipment designed to use electricity. This factor loads these incremental capital costs into estimated fuel costs.			
Implied Per Unit Cost Electricity Avoided by Biomass/Biogas/Landfill Gas	**21.59**	**21.59**	$/MWh
Incremental Cost for Green Power Purchase (from off-site, beyond supply RPS)	25.00	16.71	$/MWh
Placeholder assumption, but should be linked to RCI-9, if necessary.			
Implied use of biomass/biogas/landfill gas by year	**31.84**	**291.42**	Billion Btu

Results	2010	2020	Units
Electricity (Conventional)			
Reduction in Electricity Sales: Residential	343	3,139	GWh (sales)
Reduction in Electricity Sales: Commercial	359	3,290	GWh (sales)
TOTAL Reduction in Electricity Sales	702	6,429	GWh (sales)
Reduction in Generation Requirements	748	6,810	GWh (generation)
GHG Emission Savings	**0.66**	**4.85**	$MMtCO_2e$
Economic Analysis			
Net Present Value (2007-2020)		**-$431**	$million
Cumulative Emissions Reductions (2007-2020)		32.0	$MMtCO_2e$
Cost-Effectiveness		**-$13.47**	$/tCO_2e$
Natural Gas			
Reduction in Gas Use, Residential Sector	417	3,813	
Reduction in Gas Use, Commercial Sector	350	3,205	Billion BTU
TOTAL Reduction in Electricity Sales	767	7,018	
GHG Emission Savings	**0.04**	**0.37**	$MMtCO_2e$
Economic Analysis			
Net Present Value (2007-2020)		**-$64**	$million
Cumulative Emissions Reductions (2007-2020)		2.23	$MMtCO_2e$
Cost-Effectiveness		**-$28.60**	$/tCO_2e$
Biomass/Biogas/Landfill Gas Fuel Use			
Added GHG Emissions from Biomass Fuels Use	**0.00009**	**0.00081**	$MMtCO_2e$
Cumulative added Emissions from Biomass Fuels (2007-2020)		0.0050	$MMtCO_2e$

Summary Results for RCI-7	2010	2020	Units
Total for Option (Natural gas and Electricity less Biomass)			
GHG Emission Savings	**0.70**	**5.22**	$MMtCO_2e$
Net Present Value (2007-2020)		**-$494.2**	$million
Cumulative Emissions Reductions (2007-2020)		34.2	$MMtCO_2e$
Cost-Effectiveness		**-$14.45**	$/tCO_2e$

NOTES AND DATA FROM SOURCES

Note 1:

From The Energy Efficiency Task Force Report to the Clean and Diversified Energy Advisory Committee of the Western Governors Association.
The Potential for More Efficient Electricity Use in the Western United States, January, 2006. This report is referred to here as the "WGA CDEAC EE report" and can be found at:
http://www.westgov.org/wga/initiatives/cdeac/Energy%20Efficiency-full.pdf.
See *Note 1* in RCI-6 worksheet in this workbook.

Note 2:

Based on results from Table B.5 of the 2003 Commercial Buildings Energy Consumption Survey, Detailed Tables dated October 2006 and published by the US Department of Energy's Energy Information Administration, and available as http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/pdf2003/alltables.pdf, as described in "NC_Activities_Est" worksheet in this workbook.

Following data on electricity sales in North Carolina as of 2005 as described in "Utility_Sales" worksheet in this workbook. Downloaded from http://www.eia.doe.gov/cneaf/electricity/epa/epa_sprdshts.html (file sales_revenue.xls)

	MWh	Fraction of Total
Residential	54,072,734	42%
Commercial	44,161,328	34%
Industrial	30,101,279	23%
Total	128,335,341	100%

For natural gas consumpation, consumption data from the USDOE EIA downloaded from http://www.eia.doe.gov/oil_gas/natural_gas/applications/eia176query.html are are follows:
(See "EIA_NG_Data" worksheet in this workbook for raw EIA data)

	Sales (Million Cubic Feet of Natural Gas)			
	Residential	Commercial	Industrial	Total
2005	63,865	41,776	22,956	128,597
Fraction of 2005 Total	50%	32%	18%	100%

Note 3:

The estimate of 0.3 unit of renovated space per unit of new construction in the commercial sector is a rough assumption.
It is likely that the ratio of commercial space undergoing major renovation to new commerial space will fluctuate year by year. A review of CBECS data (Table B5, see reference above) suggests that in the South Atlantic Region renovated space (space renovated since 1980) is about one-third of new commercial building space constructed since 1980. Some of these renovations likely would not affect building energy performance, but CBECS data suggest that a substantial portion of renovated space involves changes to outside walls and roofs, additions or annexes, or changes to HVAC systems, all of which would seem to be markets for RCI-7.
It is clear that the renovation market represents a substantial opportunity for improving energy efficiency through "beyond code" changes.
Looking at the few easily accessible studies nationwide, a study of the non-residential renovation market in California (Remodeling and Renovation of Nonresidential Buildings in California, by Donald R. Dohrmann, John H. Reed, Sylvia Bender, Catherine Chappell, and Pierre Landry, available as http://www.energy.ca.gov/papers/2002-08-18_aceee_presentations/PANEL-10_DOHRMANN.PDF) suggests that by 1999 the value of renovations and additions to non-residential space was similar to that in new non-residential space, based on building permit data. As both California and North Carolina include a significant fraction of older buildings in their building stocks, the analogy with California may be reasonable for North Carolina. A study for a Texas building code report, however (see http://www.pnl.gov/main/publications/external/technical_reports/PNNL-15356.pdf) referenced the California report, but concluded that a more appropriate "conservative" value was approximately 20 percent as a long-term national average.

Estimate of Mitigation Option Costs and Benefits for North Carolina RCI GHG Analysis

RCI-9 Green Power Purchasing (required for State facilities) and Bulk Purchasing Programs for Energy Efficiency or Other Equipment

Date Last Modified:	6/1/2007 D. Von Hippel/A Bailie

Key Data and Assumptions	2010	2020/all	Units

Current State/Local Government Building Energy Consumption

Estimated Electricity Purchases (State Govt) in 2005 — 2,040 GWh

Estimate, pending receipt of specific information from State agencies, based on commercial-sector sales in North Carolina, NC-specific estimates of State-owned floorspace, and the ratio of state to local-government floorspace in USDOE EIA CBECS results for the South Atlantic region. See "Utility_Sales", "NC_Activities_Est", and "RCI-3" worksheets in this workbook.

Estimated Electricity Purchases (Local Govt), est. 2005 — 5,839 GWh

Estimate, pending receipt of specific information from State agencies, based on commercial-sector sales in North Carolina, NC-specific estimates of State-owned floorspace, and the ratio of state to local-government floorspace in USDOE EIA CBECS results for the South Atlantic region. See "Utility_Sales", "NC_Activities_Est", and "RCI-3" worksheets in this workbook. Currently only State purchases are included in this Green Power option.

Fraction of statewide commercial sector employment in local government — 20%

Data for mid-2005, includes "government" (probably state, federal, and local), but excludes educational services. Based on data from the US Bureau of Labor Statistics. See "NC_Activities_Est" worksheet in this workbook. This figure provided for information only.

Rate of growth in state building electricity demand — 0.0% per year

Assumes that growth in electricity demand is offset by savings from other efficiency/design measures.

Green Power Procurement:

Green Power Purchase (fraction of statewide sales, all sectors), 2006 — 0.016%

Based on "annual equivalent energy" data for 2006 from most recent quarterly newsletter of North Carolina Greenpower (http://www.ncgreenpower.org/media/newsletters/2006/newsletter_fall2006.html?#update).

Program Start Year — 2008

Assumed same as start year of renewable energy component of Environmental Portfolio Standard under consideration by CAPAG Energy Supply TWG.

Target Year for Achieving Purchase Level — 2018

Electricity purchased by state agencies from green (renewable energy) sources in Target Year as a fraction of total state power demand — 20%

This is an amount OVER AND ABOVE the total renewable energy included in standard purchased electricity. At this level of implementation, in combination with other RCI options and ES options that call for development of renewable-energy-based electricity generation, the total required renewable electricity by 2020 is somewhat less than the "Practical Energy Potential" identified (for example, in Table ES-1) in the report ANALYSIS OF A RENEWABLE PORTFOLIO STANDARD FOR THE STATE OF NORTH CAROLINA, prepared for the North Carolina Utilities Commission by LaCapra Associates, and dated December, 2006. Note that this "Practical Energy Potential" estimate does not include energy from offshore wind power or from solar photovoltaic power.

Fraction of other (all sector) demand adopting state targets — 0.0%

Implementation measures suggested in the current (10/31/06) version of the RCI-9 description mention incentives provided by the state to induce private sector electricity users to buy green power. No specific goals for doing so, however, are provided at present. This figure is thus set to zero as a placeholder value, pending TWG input.

Incremental Cost of Green Power — $ 25.00 | $ 16.71 /MWh

This represents the approximate added consumer cost of green power, assuming bulk purchase (see e.g. NC GreenPower program at http://www.ncgreenpower.org/about/index.html where bulk purchases of over 10 MWh pay $25/MWh), and assumes that bulk purchase costs will fall by 2017 to the level of the average net cost of renewable generation calculated from data from a report on the prospects for renewable generation in North Carolina by La Capra Associates (see "La_Capra_Data" worksheet in this workbook). The incremental cost of green power is assumed to stay constant (in real terms) after 2017. This is a rough approximation. The incremental cost (and cost-effectiveness) of this measure may also be reflected in the cost of the RPS policy (see ES group), since it considers costs at the wholesale not retail level, from an economic rather than financial perspective.

Bulk Purchase Program:

Fraction of State agency electricity demand addressed by bulk purchasing program — 10%
Placeholder estimate.

Fraction of all-sector (excluding government) electricity demand addressed by bulk purchasing program — 1%
Placeholder estimate.

Average lifetime of devices included in bulk purchasing program — 10 years
Placeholder estimate--designed to be an average between longer-lived equipment such as water heaters and air conditioners, and shorter-lived devices such as computers.

Fractional savings from bulk purchase program relative to standard-efficiency equipment, appliances, and other devices. — 20%
Placeholder estimate, but consistent with an average of fractional savings possible with many different types of higher-than-standard efficiency appliances, equipment, and other devices.

Assumed Cost of Bulk Purchase Program Savings — $12 $/MWh
Pending receipt of more specific information, assumed to be similar to the cost of market transformation programs. Figure used is the same as used in RCI-4 worksheet in this workbook (From WGA EE Task Force study (2005), which cites the Retrospective Analysis of the Northwest Energy Efficiency Alliance (Violette, Ozog, and Cooney, 2003).)

Program Start Year — 2010
Assumed same as for Green Power Component.

Target Year for Achieving Purchase Level — 2018
Assumed same as for Green Power Component.

Avoided Electricity Cost — $57 $/MWh
See common assumptions.

Other Data, Assumptions, Calculations	2010	2020/all	Units
North Carolina All-Sector Electricity Use	134,876	159,498	
See RCI-1 (figures based on 2005 utility sales and forecast prepared for CAPAG process).			
Fraction of electricity from green (renewable energy) sources by year	5.5%	20.0%	
State Building Electricity Use	2,040	2,040	GWh
Net of efficiency measures from other programs and options. Does not currently include local government electricity use.			
Fractional implementation of Bulk Purchase Program targets	11.1%	100.0%	
Annual Savings from Bulk Purchase Program (not cumulative)			
State Agency Program	0.5	4.1	GWh
All-sectors (non-State) Program	3.0	31.5	GWh

Results	2010	2020	Units
Green Power			
Green Power Purchased, Current Programs, All Sectors	21.0	24.8	GWh (sales)
Green Power Requirement, Current Programs, All Sectors	22.3	26.4	GWh (generation)
GHG Emission Savings	0.020	0.019	$MMtCO_2e$
Green Power Purchased, Expanded Program	111	408	GWh (sales)
Green Power Requirement, Expanded Programs	118	434	GWh (generation)
GHG Emission Savings	0.10	0.31	$MMtCO_2e$
Economic Analysis			
Net Present Value (2007-2020)		$37	$million
Cumulative Emissions Reductions (2007-2020)		2.7	$MMtCO_2e$
Cost-Effectiveness		$13.7	$/tCO_2e$
Bulk Purchase Program:			
Savings from Bulk Purchase Program, All Sectors	3	237	GWh (sales)
Savings from Bulk Purchase Program, All Sectors	4	252	GWh (generation)
GHG Emission Savings	0.00	0.17	$MMtCO_2e$
Economic Analysis			
Net Present Value (2007-2020)		-$26	$million
Cumulative Emissions Reductions (2007-2020)		0.8	$MMtCO_2e$
Cost-Effectiveness		-$34.0	$/tCO_2e$

Summary Results for RCI-9	2010	2020	Units
Total for Option (Green Power and Bulk Purchase Programs)			
GHG Emission Savings	0.11	0.48	$MMtCO_2e$
Net Present Value (2007-2020)		$10.7	$million
Cumulative Emissions Reductions (2007-2020)		3.5	$MMtCO_2e$
Cost-Effectiveness		$3.07	$/tCO_2e$

Estimate of Mitigation Option Costs and Benefits for North Carolina RCI GHG Analysis

RCI-10 **Distributed Renewable and Clean Fossil Fuel Power Generation**

Date Last Modified:	*6/5/2007 D. Von Hippel/A Bailie*

Key Data and Assumptions	2010	2020/all	Units
First Year Results Accrue		2008	
Avoided Electricity Cost *Weighted average over total 2007-2020 electricity savings for this policy in each sector. See common assumptions ("Common Factors" worksheet in this workbook).*		$57	$/MWh
Avoided Natural Gas Cost *See common assumptions ("Common Factors" worksheet in this workbook)*		$8.0	$/MMBtu
Avoided LPG Cost *See common assumptions ("Common Factors" worksheet in this workbook)*		$12	$/MMBtu
Target Year for Reaching Solar Hot Water (SHW) Implementation Level		2020	
Fraction of additional existing North Carolina Homes with Solar HW by Target Year *Option Design states "An additional 2 to 4 percent of all NC homes will have SHW installations by 2020." Midpoint of range chosen.*		3%	
Target Year for Reaching Combined Heat and Power (CHP) Implementation Level		2020	
Fraction of additional NC CHP Implementation Potential Achieved by Target Year *Option Design states "Implementation of 25-33% of North Carolina's CHP potential by 2020". Midpoint of range chosen.*		29%	
Target Year for Reaching Distributed Renewable Generation Implementation Level		2020	
Additional NC Renewable Distributed Generation Achieved by Target Year *Option Design states "35 additional MW of distributed renewable generation over and above RPS-related new generation by 2020", but also, "The CAPAG suggests that the TWG consider 'tightening up this target and going further'".*		35	MW

Other Data, Assumptions, Calculations	2010	2020/all
Residential Sector Water Heating		
Number of Total Housing Units in North Carolina (thousand) *Assumes 2005 ratio of new homes to increase in population holds through 2020.*	4,358,500	5,210,875
Fraction of Additional Housing Units Solar Water Heat through Program	0.7%	3.0%
Fraction of Housing Units Using Non-Solar Water Heat In Absence of Program		
Fraction Using Electricity	35.0%	34.9%
Fraction Using Natural Gas	65.0%	65.1%
Fraction Using LPG	5.0%	5.0%
Fraction Using Solar (alone or with back-up, before policy) *Rough Estimates Pending Receipt of State-Specific Data.*	5.0%	5.0%

Use of Electricity and Other (non-solar) Energy Sources per (non-solar) Household in Absence of Program

Electricity	**4,000**	**3,810**	kWh
Natural Gas	18.13	17.27	MMBtu
LPG	18.13	17.27	MMBtu

Value for 2010 assumes 4000 kWh per HH using electricity for water heat, which is a rough estimate pending receipt of state-specific data. Estimates for gas and lpg base on average EF of .93 for Electricity, .7 for Natural Gas/LPG. Value in 2020 assumes 5% reduction in water heating energy use between 2010 and 2020 due to reduction in number of people per household plus naturally occuring energy efficiency improvements.

Additional Households Using Solar HW Under Program (thousand)	30.2	156.3
Fraction of household hot water needs provided by solar HW units	**80.0%**	**85.0%**

Placeholder Assumption--Back-up fuels used for water heating in housing units with solar water heating are assumed to be distributed based on the pre-Policy fractions given above.

Savings of Electricity and Other (non-solar) Energy Sources Due to Program

Electricity	35.6	186.2	GWh
Natural Gas	0.285	1.493	TBtu
LPG	0.022	0.115	TBtu

Incremental Capital Cost of Solar Water Heater (relative to electric or gas unit)	**$3,500**	**$3,000**

Placeholder Assumption, pending receipt of NC-specific data.

Implied Cumulative Additional Annualized Capital Costs for Residential Solar Hot Waters Installed as a Result of Policy (thousand 2005 dollars)	**$ 7,178**	**$ 34,715**

Factors for Annualizing Capital Costs (Residential Solar Hot Water Systems)

Interest Rate (real)	7%	/yr
Economic Life of System	20	years
Implied Annualization Factor	9.44%	%/yr
Marginal Federal Tax Rate, Residential	28%	

Federal Solar Tax Credits: Residential Sector--See ***Note 3***	0%	0%

Reduce Captial Costs for Solar Tax Credits and Federal Mortgage Deductions?	**YES**

Used for both Residential and Commercial Sectors

Intermediate Results: Residential SWH Program

Reduction in Electricity Sales from SWH Program: Residential	36	186	GWh (sales)
Reduction in Generation Requirements	38	197	GWh (generation)
GHG Emission Savings	**0.03**	**0.14**	$MMtCO_2e$

Economic Analysis (for Electricity Savings due to SWH Program)

Net Present Value (2007-2020)	**$5.8**	$million
Cumulative Emissions Reductions (2007-2020)	1.0	$MMtCO_2e$
Cost-Effectiveness	**$5.80**	$/tCO_2e$

Natural Gas

Savings due to Implementation of SWH Program

Reduction in Gas Use	494	1,493	Billion BTU
GHG Emission Savings	0.03	0.08	$MMtCO_2e$

Economic Analysis (for Gas Savings due to SWH Program)

Net Present Value (2007-2020)	**$41.4**	$million
Cumulative Emissions Reductions (2007-2020)	0.51	$MMtCO_2e$
Cost-Effectiveness	**$81.88**	$/tCO_2e$

LPG

Savings due to Implementation of SWH Program

Reduction in Gas Use	38	115	Billion BTU
GHG Emission Savings	0.00	0.01	$MMtCO_2e$

Economic Analysis (for LPG Savings due to SWH Program)

Net Present Value (2007-2020)	**$1.2**	$million
Cumulative Emissions Reductions (2007-2020)	0.047	$MMtCO_2e$
Cost-Effectiveness	**$26.24**	$/tCO_2e$

Commercial and Industrial Combined Heat and Power

North Carolina Potential for Combined Heat and Power as of 2000: 3,545 MW

*Estimated based on older "Onsite Sycom" documents; see **Note 1**. May be revisited if more current and NC-specific data are available.*

Estimated Future North Carolina Potential for Combined Heat and Power	3,811	4,417	MW
Potential assumed to scale with forecast commercial plus industrial electricity sales.			
Fraction of Potential Installed Under Program (Cumulative)	6.7%	29.0%	
MW CHP Installed Under Program (annual installations)	87	116	MW
Average full-capacity-equivalent hours of operation for New CHP units: *(Assumption)*	5,000	5,000	
Fraction of New CHP Capacity/Energy Fueled With:			
Natural Gas	90%	82.5%	
Biomass	6%	17.5%	
Coal	4%	0.0%	

Targets; for biomass (including biomass generation capacity included under "distributed generation", below), goal is to provide approximately 750 GWh by 2020, or about 10 percent of "practical potential" for biomass-fueled power (not co-fired) as indicated in the "La Capra Report" (page 19). The 953 MW of potential biomass-fueled generation, assuming the same 90% capacity factor assumed by La Capra, suggests a total potential generation of ABOUT 7500 GWh. See below for full reference to LaCapra Report.

Implied Annual New CHP Capacity by Fuel (MW)		
Natural Gas	78.42	95.88
Biomass	5.23	20.34
Coal	3.49	-
Implied Cumulative New CHP Capacity by Fuel (MW)		
Natural Gas	229.57	1,108.69
Biomass	15.30	144.59
Coal	10.20	27.68
Implied Cumulative New CHP Electricity Output by Fuel (GWh)		
Natural Gas	1,148	5,543
Biomass	77	723
Coal	51	138
Average Net Heat Rate by Fuel (Btu Fuel Input/kWh Electricity Output)		
Natural Gas	10,000	10,000
Biomass	13,500	13,500
Coal	12,000	12,000

*Rough estimates, as heat rates vary by installation. Heat rates for natural gas-fueled units consistent with values from AEO report provided in **Note 7**, below.*

Implied Fuel Input by Fuel (Billion Btu)		
Natural Gas	11,478	55,435
Biomass	1,033	9,760
Coal	612	1,661
Usable Cogenerated Heat Output as a Fraction of Fuel Energy Input		
Natural Gas	40%	40%
Biomass	40%	40%
Coal	40%	40%
Implied Usable Heat Output by Fuel (Billion Btu)		
Natural Gas	4,591	22,174
Biomass	413	3,904
Coal	245	664
Fraction of Usable Heat Output Replacing Space/Water/Process Heat Use *(Assumption)*	90%	90%
Fraction of CHP Heat Output Displacing Thermal Energy Produced Using		
Natural Gas	45%	45%
Biomass	7%	7%
Coal	5%	5%
Electricity	22%	22%
Oil	21%	21%

Assumptions based roughly on forecast commercial plus industrial sector demand for these fuels as of 2015.

Net Efficiency of Displaced Boiler/Heater Thermal Energy Produced Using

Natural Gas	85%	85%
Biomass	80%	80%
Coal	80%	80%
Electricity	92%	92%
Oil	80%	80%

Assumptions

Net Displaced Fuel Use (Billion Btu)

Natural Gas	**2,501**	**12,742**
Biomass	**413**	**2,106**
Coal	**295**	**1,504**
Electricity	**1,130**	**5,755**
Oil	**1,240**	**6,318**

Inputs to Cost Estimates for CHP Systems

Estimated Average Installed Capital Costs by System Type ($2005/kW)

Natural Gas	$ 1,500	$ 1,100
Biomass	$ 2,400	$ 2,000
Coal	$ 2,200	$ 2,000

For biomass systems, this value is somewhat less than the cost of wood-fired (electricity-only) systems as described on page 117 of the "LaCapra Report", ANALYSIS OF A RENEWABLE PORTFOLIO STANDARD FOR THE STATE OF NORTH CAROLINA, TECHNICAL REPORT, prepared by La Capra Associates for the North Carolina Utilities Commission, and dated December, 2006 (document available as http://www.ncuc.commerce.state.nc.us/rps/NC%20RPS%20Report%2012-06.pdf), but at the high end of the range of costs given in the presentation "Biomass to Energy:Present Commercial Strategies and Future Options", by John Scahill of the NREL National Bioenergy Center (dated January, 2003). The latter document includes a projection of a decline in biomass generation costs over time. Costs for natural gas systems are a very rough average over a range of possible technologies and capacities that are used in the commercial and industrial sectors. Sources include the AEO2007 data listed in ***Note 7****, below, and the two older ONSITE-SYCOM studies also listed in Note 8. Costs for coal-fired systems are rough estimates at present.*

Factors for Annualizing Capital Costs (all plant types)

Interest Rate	8%	/yr
Economic Life of System	20	years
Implied Annualization Factor	10.19%	%/yr

Estimated Average Non-fuel Operating and Maintenance Costs by System Type ($/MWh)

Natural Gas	$ 10.00	$ 10.00
Biomass	$ 25.00	$ 20.00
Coal	$ 20.00	$ 20.00

For biomass systems, similar to sum of fixed and viabled O&M costs for wood-fired (electricity-only) systems as described on page 1187 of the "LaCapra Report" referenced above. Natural gas O&M costs vary by system size and type. Value shown here is a rough estimate based on data in the Onsite/Sycom reports referenced in Note 1 and in other sources. O&M costs for coal-fired plants are rough estimates.

Intermediate Results for Cost Estimates

Total Capital Costs for New Systems (thousand 2005 dollars)		
Natural Gas	$ 117,633	$ 105,467
Biomass	$ 12,548	$ 40,676
Coal	$ 7,668	$ -
Annualized Capital Costs for All Systems (thousand 2005 dollars)		
Natural Gas	$ 35,073	$ 149,079
Biomass	$ 3,741	$ 31,926
Coal	$ 2,286	$ 6,067
Annual Non-Fuel Operating and Maintenance Costs for All Systems (thousand 2005 dollars)		
Natural Gas	$ 11,478	$ 55,435
Biomass	$ 1,913	$ 14,459
Coal	$ 1,020	$ 2,768
Total Non-Fuel Costs for All Systems (thousand 2005 dollars)		
Natural Gas	$ 46,551	$ 204,514
Biomass	$ 5,654	$ 46,385
Coal	$ 3,307	$ 8,834
Total Gross Fuel Costs for All Systems (thousand 2005 dollars)		
Natural Gas	$ 90,606	$ 429,654
Biomass	$ 2,460	$ 23,244
Coal	$ 1,493	$ 4,051

Evaluated based on avoided costs estimates--See "Common Factors" worksheet in this workbook.

Total Fuel Cost Savings from Displaced Heating Fuels for All Systems (thousand 2005 dollars)		
Natural Gas	$ 19,744	$ 98,757
Biomass	$ 985	$ 5,016
Coal	$ 720	$ 3,669
Electricity	$ 18,757	$ 95,555
Oil	$ 16,587	$ 84,497

Evaluated based on avoided costs estimates--See "Common Factors" worksheet in this workbook.

Intermediate Results: Commercial/Industrial CHP

Electricity			
TOTAL Reduction in Electricity Sales (electricity output from CHP plus avoided electricity use in boilers/space heaters/water heaters)	1,606	8,092	GWh (sales)
Reduction in Generation Requirements	1,710	8,572	GWh (generation)
Gross GHG Emission Savings	1.50	6.11	$MMtCO_2e$
Natural Gas			
Net Change in Gas Use (negative values denote increased use)	-8,977	-42,693	Billion BTU
Net GHG Emissions (negative values denote increased emissions)	-0.47	-2.22	$MMtCO_2e$
Biomass			
Net Change in Biomass Use (negative values denote increased use)	-620	-7,654	Billion BTU
Net GHG Emissions (negative values denote increased emissions)	-0.002	-0.021	$MMtCO_2e$
Coal			
Net Change in Coal Use (negative values denote increased use)	-317	-157	Billion BTU
Net GHG Emissions (negative values denote increased emissions)	-0.03	-0.01	$MMtCO_2e$
Oil			
Net Change in Oil Use (negative values denote increased use)	1,240	6,318	Billion BTU
Net GHG Emissions (negative values denote increased emissions)	0.09	0.47	$MMtCO_2e$
Total for CHP Program (All Fuels)			
Total Net GHG Emission Savings	1.10	4.32	$MMtCO_2e$
Net Present Value (2007-2020)		$312	$million
Cumulative Emissions Reductions (2006-2020)		31.4	$MMtCO_2e$
Cost-Effectiveness		$9.93	$/tCO_2e$

Renewable Distributed Generation (DG)

Total Additional Capacity of Renewable DG Built under Program	8.1	35.0	MW
Annual Additional Capacity of Renewable DG Built under Program	2.7	2.7	MW
Fraction of Additional Capacity As			
Residential PV Systems	35%	40%	
Commercial PV Systems	35%	40%	
Customer-sited Landfill Gas	10%	5%	
Customer-sited Biomass	15%	12%	
Customer-sited Biogas	5%	3%	
Average Capacity of Solar PV System Installed on Homes (kW)	3.00	3.00	
*Assumption, consistent with capacity assumption used in Source in **Note 2**.*			
Average Capacity of Solar PV System Installed on Commercial Buildings (kW)	20.00	20.00	
*Assumption, roughly consistent, per square foot of floor area. with capacity assumptions for new and existing residential buildings used in Source in **Note 2**. See also **Note 6** for calculation of average floor area of commercial builidngs.*			
Number of Homes Installing Solar PV Systems Annually	314	359	
Total Number of Homes with Solar PV Systems Installed under this Option, 2008 to 2020:	4,330		
*Note that a cummulative ~4,300 solar PV systems by 2020 is considerably less, on a per-capita basis, than the 1.2 million solar homes by 2020 used in an estimate of solar PV contributions to GHG emissions reduction in California (see **Note 2**).*			
Implied number of Commercial Solar PV Systems Added Annually	47	54	
Calculated based on target capacity and capacity-per-building assumption above.			
Total Annual Residential Solar PV Capacity Installed on Homes (MW)	0.94	1.08	
Total Annual Commercial Solar PV Capacity Installed (all Buildings) (MW)	0.94	1.08	
Estimated Annual Total Solar PV Installed Under Policy by Year (MW)	1.88	2.15	
Estimated Cumulative Total Solar PV Installed Under Policy by Year (MW)	5.65	25.98	
Average full-capacity-equivalent hours of operation for Solar PV Systems:	1,691	1,691	
*Based on data for Raleigh in figure in guide document from North Carolina Solar Center--See **Note 4**.*			
Implied New Solar PV Output, Cumulative Systems (GWh)	10	44	
Implied Annual New Biomass/Landfill Gas/Biogas-fueled Capacity by Fuel (MW)			
Landfill Gas	0.27	0.13	
Biomass	0.40	0.32	
Biogas	0.13	0.08	
Implied Cumulative New Biomass/Landfill Gas/Biogas-fueled Capacity by Fuel (MW)			
Landfill Gas	0.81	2.76	
Biomass	1.21	4.81	
Biogas	0.40	1.45	
Average Full-capacity-equivalent Hours of Operation for Systems Above:	5,000	5,000	
Placeholder Assumptions			
Implied Cumulative New Biomass/Landfill Gas/Biogas-fueled Electricity Output by Fuel (GWh)			
Landfill Gas	4.0	13.8	
Biomass	6.1	24.0	
Biogas	2.0	7.3	
Average Net Heat Rate by Fuel (Btu Fuel Input/kWh Electricity Output)			
Landfill Gas	10,000	10,000	
Biomass	12,500	12,500	
Biogas	10,000	10,000	
*Rough estimates, as heat rates vary by installation. Heat rates for landfill and biogas-fueled units consistent with values for natural gas CHP from AEO report provided in **Note 7**, below.*			
Implied Fuel Input by Fuel (Billion Btu)			
Landfill Gas	40	138	
Biomass	76	300	
Biogas	20	73	

Inputs to Cost Estimates for Solar PV Systems (Data from Source in *Note 3*)

Capital Costs for PV Systems for Homes		
Module	$ 3,749	$ 2,245
BOS (Balance of System)	$ 1,250	$ 748
Installation	$ 903	$ 315
Total System - $/kW	$ 5,902	$ 3,308
Total System - $	$ 17,706	$ 9,924
Commercial System Capital costs/kW Relative to New Residential	80%	80%
*Rough assumption, but similar to values in literature--See **Note 5**.*		
Solar PV Operating and Maintenance (O&M) Costs ($/MWh)	$ 5.88	$ 5.88
*Rough assumption--See **Note 6**.*		
Federal Solar Tax Credits: Residential Sector--See ***Note 3***	0%	0%
Federal Solar Tax Credits: Commercial and Industrial Sectors--See ***Note 3***	10%	10%

Factors for Annualizing Capital Costs (Residential PV Systems)		
Interest Rate	7%	/yr
Economic Life of System	20	years
Implied Annualization Factor	9.44%	%/yr
Marginal Federal Tax Rate, Residential	28%	
Factors for Annualizing Capital Costs (Commercial PV Systems)		
Interest Rate	8%	/yr
Economic Life of System	20	years
Implied Annualization Factor	10.19%	%/yr
Reduce Captial Costs for Solar Tax Credits and Federal Mortgage Deductions?	YES	

Intermediate Results for Solar PV System Cost Estimates

Total Capital Costs for New Systems (thousand 2005 dollars) Net of Tax Credits		
Systems for Residences	$ 5,562	$ 3,562
Systems for Commercial Installations	$ 4,004	$ 2,565
Annualized Capital Costs for All Systems (thousand 2005 dollars)		
Systems for Residences	$ 1,205	$ 4,185
Systems for Commercial Installations	$ 1,301	$ 4,515
Annual Operating and Maintenance Costs for All Systems (thousand 2005 $)	$ 56	$ 258

Inputs to Cost Estimates for Biomass/Landfill Gas/Biogas-fueled Systems

Estimated Average Installed Capital Costs by System Type ($2005/kW)		
Landfill Gas	$ 1,700	$ 1,200
Biomass	$ 2,400	$ 2,000
Biogas	$ 1,700	$ 1,200

Estimates for Landfill Gas and Biogas plants assume slightly higher costs than for gas-fired CHP due to the need for equipment to purify incoming fuel gas. Biomass plant costs assumed the same as biomass CHP costs.

Factors for Annualizing Capital Costs (all plant types)		
Interest Rate	8%	/yr
Economic Life of System	20	years
Implied Annualization Factor	10.19%	%/yr

Estimated Average Non-fuel Operating and Maintenance Costs by System Type ($/MWh)		
Landfill Gas	$ 20.00	$ 20.00
Biomass	$ 25.00	$ 25.00
Biogas	$ 20.00	$ 20.00

Placeholder Assumptions

Intermediate Results for Biomass/Landfill Gas/Biogas-fueled Cost Estimates

Total Capital Costs for New Systems (thousand 2005 dollars)		
Landfill Gas	$ 458	$ 162
Biomass	$ 969	$ 646
Biogas	$ 229	$ 97
Annualized Capital Costs for All Systems (thousand 2005 dollars)		
Landfill Gas	$ 140	$ 471
Biomass	$ 296	$ 1,162
Biogas	$ 70	$ 248
Annual Non-Fuel Operating and Maintenance Costs for All Systems (thousand 2005 dollars)		
Landfill Gas	$ 81	$ 276
Biomass	$ 151	$ 601
Biogas	$ 40	$ 145
Total Non-Fuel Costs for All Systems (thousand 2005 dollars)		
Landfill Gas	$ 221	$ 747
Biomass	$ 448	$ 1,762
Biogas	$ 110	$ 393
Total Fuel Costs for All Systems (thousand 2005 dollars)		
Landfill Gas	$ 202	$ 690
Biomass	$ 180	$ 715
Biogas	$ 101	$ 363

Intermediate Summary Results for Renewable Distributed Generation Program

Total Electricity Output	21.7	89.0
Total Cost (thousand 2005 dollars, net of value of electricity output)	$ 2,054	$ 6,097

Results	2010	2020	Units
Savings due to Implementation of RCI-10 Programs			
Electricity			
TOTAL Reduction in Electricity Sales (savings from SWH/CHP plus electricity output from CHP/Solar PV and landfill gas/biomass/biogas systems)	1,664	8,367	GWh (sales)
Reduction in Generation Requirements	1,771	8,864	GWh (generation)
Gross GHG Emission Savings	**1.56**	**6.32**	$MMtCO_2e$
Natural Gas			
Net Change in Gas Use (negative values denote increased use)	-8,693	-41,200	Billion BTU
Net GHG Emissions (negative values denote increased emissions)	-0.45	-2.15	$MMtCO_2e$
LPG			
Net Change in Gas Use (negative values denote increased use)	22	115	Billion BTU
Net GHG Emissions (negative values denote increased emissions)	0.00	0.01	$MMtCO_2e$
Coal			
Net Change in Coal Use (negative values denote increased use)	-317	-157	Billion BTU
Net GHG Emissions (negative values denote increased emissions)	-0.03	-0.01	$MMtCO_2e$
Oil			
Net Change in Oil Use (negative values denote increased use)	1,240	6,318	Billion BTU
Net GHG Emissions (negative values denote increased emissions)	0.09	0.47	$MMtCO_2e$
Landfill Gas			
Net Change in Gas Use (negative values denote increased use)	-40	-138	Billion BTU
Net GHG Emissions (negative values denote increased emissions)	0.0000	0.0000	$MMtCO_2e$
Biomass			
Net Change in Biomass Use (negative values denote increased use)	-695	-7,954	Billion BTU
Net GHG Emissions (negative values denote increased emissions)	-0.002	-0.022	$MMtCO_2e$
Biogas			
Net Change in Gas Use (negative values denote increased use)	-20	-73	Billion BTU
Net GHG Emissions (negative values denote increased emissions)	0.0000	0.0000	$MMtCO_2e$

Summary Results for RCI-10	2010	2020	Units
Total for Policy (Electricity, Natural Gas, LPG, Oil, Landfill Gas, Biomass, Biogas)			
GHG Emission Savings	**1.17**	**4.61**	$MMtCO_2e$
Net Present Value (2007-2020)		**$392**	$million
Cumulative Emissions Reductions (2007-2020)		**33.5**	$MMtCO_2e$
Cost-Effectiveness		**$11.71**	$/tCO_2e$

NOTES AND DATA FROM SOURCES

Note 1:

Following data from
ONSITE SYCOM Commercial CHP Report - Appendix B-2 [presumably for year 2000]
Report title: The Market and Technical Potential for Combined Heat and Power in the Commercial/Institutional Sector
Prepared for the U.S. Department of Energy Energy Information Administration, dated January, 2000.

	Potential (MW) by Size Class				
State	*100-500 kW*	*500-1000 kW*	*1 - 5 MW*	*> 5 MW*	*Total*
North Carolina	800.4	719.6	622.1	265.6	2,408

Lacking (to date) an independent estimate of the CHP potential for the Industrial sector in NC, the approach here is to start with an estimate for the overall CHP potential in different size classes nationwide, prepared for the USDOE Energy Information Administration by ONSITE SYCOM Energy, January 2000) then estimate the remaining potential in NC based on the fraction of national industrial-sector electricity use that occurs in the State.

Total US electricity sales to Industrial Customers, 2000:	1,064,239,391	GWh
Total NC electricity sales to Industrial Customers, 2000:	34,251,860	GWh (estimated in workbook
Implied NC fraction of US industrial electricity use:	3.22%	

From data on electricity sales in North Carolina and the US as of 2000 as described in "Utility_Sales" worksheet in this workbook.
Downloaded from http://www.eia.doe.gov/cneaf/electricity/epa/epa_sprdshts.html (file sales_revenue.xls)

Data in the ONSITE SYCOM Industrial CHP report suggests that NC had an installed CHP base of 1258 MW as of about 2000, of which very little appeared to be in units under 10 MW in capacity (tables 2.10, 2.11), since the total capacity was spread among only 33 units.

Following Data from Table 3.3 of ONSITE SYCOM report:

CHP Size Class	US Techical Potential for Industrial CHP (MW)	Implied NC Techical Potential for CHP (MW)	Estimated Existing NC CHP (MW)	Implied Remaining NC Potential for CHP (MW)
< 1 MW	21,990	707.73		
1 - 4 MW	6,439	207.24		
4 - 20 MW	13,779	443.47		
20 - 50 MW	13,799	444.11		
> 50 MW	35,361	1,138.07		
TOTAL	91,368	2,941	1,258	1,682.62
Less estimated fraction over 10 MW	56,050	1,803.92	1,258	545.92
Net under 10MW	35,319	1,136.70	-	1,137

Note 2:

Source: Worksheet "Solar Homes Summary table.xls", with calculations in support of the California Million Solar Homes Initiative, authored by XENERGY, Inc., and provided by M. Lazarus. Selected annual data provided.

Note 3:

A description of the new Federal Solar Tax Credits for businesses and residences as contained in the Energy Policy Act of 2005 (EPAct 2005) (see, for example, http://www.seia.org/getpdf.php?iid=21) provides for 30% (of system cost) tax credits for solar PV investments by businesses in 2006 and 2007, reverting to 10% thereafter. For residences, the credit in 2006 and 2007 is 30% with a "cap" of $2000, reverting to zero after 2007. For the purpose of this analysis, we are modeling the federal tax credit at its long-term (10% business, 0% residential) level, as no systems are added in 2006 and 2007.
See also, for Example,
http://www.sdenergy.org/uploads/PV-Federal%20Tax%20Credits%20Summary%206-01-04%20FINAL.pdf.

Note 4:
Source: North Carolina Consumer's Guide to Buying a Solar Electric System, From NC Solar Center, http://www.ncsc.ncsu.edu/information_resources/factsheets/cnsmrguide.pdf.

Note 5:
Source: International Energy Agency (IEA), TRENDS IN PHOTOVOLTAIC APPLICATIONS Survey report of selected IEA countries between 1992 and 2004. Report #IEA-PVPS T1-14:2005. Page 18.
"Indicative costs" in 2004 in USD per kWp (assumedly DC output) for on-grid PV systems in the US:

<10 kW	7000 to 10,000
>10 kW	6300 to 8500

In EIA Projections of Renewable Energy Costs, presented in "Forum on the Economic Impact Analysis of NJ's Proposed 20% RPS" by Chris Namovicz of the USDOE EIA (Energy Information Administration), dated February 22, 2005, and available as http://www.eia.doe.gov/oiaf/pdf/rec.pdf, a PV power average cost of

6000	dollars/kW is provided for a 25 kW Commercial system, or
8200	dollars/kW for a 2 kW Residential system, with

"Large potential for cost reduction".

Note 6:
An older (1997) US DOE document OVERVIEW OF PHOTOVOLTAIC TECHNOLOGIES (available as http://www.eere.energy.gov/ba/pdfs/pv_overview.pdf) suggests that even early solar PV systems had O&M costs of under $ 0.005 per kWh, which in 2005 dollars would be: $ 0.0059 per kWh.

Note 7:
From *Assumptions for the Annual Energy Outlook 2007*
USDOE Energy Information Administration 2007
tonto.eia.doe.gov/FTPROOT/forecasting/0554(2007).pdf

Data for Commercial sector (p. 34)

Table 13. Capital Cost and Performance Parameters of Selected Commercial Distributed Generation Technologies

Technology Type	Year	Average Generating Capacity (kW)	Electrical Efficiency	Combined Efficiency (Elec.+ Thermal)	Installed Capital Cost ($2005 per kW of Capacity)*	Service Life (Years)
Solar Photovoltaic	2005	30	0.16	N/A	$5,350	30
	2010	32	0.18	N/A	$4,045	30
	2015	35	0.2	N/A	$3,800	30
	2020	40	0.22	N/A	$3,714	30
	2025	40	0.22	N/A	$3,451	30
	2030	45	0.25	N/A	$3,015	30
Fuel Cell	2005	200	0.36	0.72	$5,946	20
	2010	200	0.44	0.66	$5,466	20
	2015	200	0.45	0.67	$5,203	20
	2020	200	0.47	0.69	$4,187	20
	2025	200	0.48	0.7	$3,674	20
	2030	200	0.49	0.72	$3,108	20
Natural Gas Engine	2005	300	0.31	0.77	$2,132	20
	2010	300	0.32	0.78	$1,878	20
	2015	300	0.32	0.78	$1,714	20
	2020	300	0.33	0.78	$1,551	20
	2025	300	0.33	0.78	$1,343	20
	2030	300	0.34	0.79	$1,134	20
Oil-Fired Engine	2005	200	0.31	0.72	$1,320	20
	2010	200	0.31	0.72	$1,150	20
	2015	200	0.31	0.71	$1.04	20
	2020	200	0.31	0.71	$990	20
	2025	200	0.31	0.71	$990	20
	2030	200	0.31	0.71	$990	20
Natural Gas Turbine	2005	1000	0.22	0.68	$2,000	20
	2010	1000	0.23	0.68	$1,775	20
	2015	1000	0.24	0.68	$1,684	20
	2020	1000	0.24	0.69	$1,593	20
	2025	1000	0.25	0.69	$1,511	20
	2030	1000	0.26	0.7	$1,429	20
Natural Gas Micro-Turbine	2005	200	0.29	0.6	$1,706	20
	2010	200	0.29	0.6	$1,648	20
	2015	200	0.31	0.61	$1,633	20
	2020	200	0.33	0.61	$1,573	20
	2025	200	0.34	0.62	$1,343	20
	2030	200	0.36	0.63	$1,052	20

Sources: Energy Information Administration, Commercial and Industrial CHP Technology Cost and Performance Data Analysis for EIA's NEMS,

Decision Analysis Corporation and Discovery Insights LLC., February 2006, National Renewable Energy Laboratory, Gas-Fired Distributed Energy Resource Technology Characterizations: Reference Number NREL/TP-620-34783, November 2003, Discovery Insights, LLC, "Installed Costs for Small CHP Systems - Estimates and Projections" (April 2005), and Solar Energy Industries Association, Our Solar Power Future - The U.S. Photovoltaic Industry Roadmap through 2030 and Beyond, (SEIA, September 2004).

Industrial Sector data from p. 54 of source

Table 22. Cost Characteristics of Industrial CHP Systems

Type	Size (kilowatts)	Installed Cost ($2005 per kilowatt)[1] 2005	2030
1 Engine	1000	1,194	860
2 Engine	3000	947	808
3 Gas Turbine	3000	1,330	1,100
4 Gas Turbine	5000	1,026	851
5 Gas Turbine	10000	960	834
6 Gas Turbine	25000	809	707
7 Gas Turbine	40000	700	646
8 Combined Cycle	100000	736	684

Source: Energy Information Administration, Model Documentation Report: Industrial Sector Demand Module of the National Energy Modeling System, DOE/EIA-MO64(2007) (Washington, DC, 2007).

Estimate of Mitigation Option Costs and Benefits for North Carolina RCI GHG Analysis

RCI-11 **Residential, Commercial, and Industrial Energy and Emissions Technical Assistance and Recommended Measure Implementation**

Date Last Modified: *5/31/2007 D. Von Hippel/A Bailie*

Key Data and Assumptions	2010	2020/all	Units
First Year Results Accrue		2008	
Levelized Cost of Electricity Savings from Technical Assistance Recommendations		$33	$/MWh
Residential Sector		$31	$/MWh
Commercial Sector		$46	$/MWh
Industrial Sector		$20	$/MWh
Levelized Cost of Natural Gas and Other Fuels Savings		$2.1	$/MMBtu
Residential Sector		$2.1	$/MMBtu
Commercial Sector		$2.1	$/MMBtu
Industrial Sector		$2.1	$/MMBtu
Avoided Electricity Cost		$57	$/MWh
Avoided Natural Gas Cost		$8.0	$/MMBtu
Avoided LPG Cost		$12.3	$/MMBtu
Avoided Oil Cost		$13.4	$/MMBtu
Annual Technical Assistance Visits: Residential Sector		10,000	
Annual Technical Assistance Visits: Commercial Sector		1,500	
Annual Technical Assistance Visits: Industrial Sector		300	
Total (all Sectors) Technical Assistance Visits Over Life of Program		153,400	

Estimated based on savings included in the GDS Report for the NC Utilities Commission, A Study of the Feasibility of Energy Efficiency as an Eligible Resource as Part of a Renewable Portfolio Standard for the State of North Carolina, dated 12/2006. See Note 1. The averages from the GDS report are based on a discount rate of 10 percent nominal, and have been approximately adjusted using a real discount rate of 5%/yr to yield the values above. See "GDS calcs" worksheet in this workbook. Estimates ulitimately used should present total costs including both costs of the technical assistance visits themselves and the costs (incremental equipment costs net of non-energy savings) of the measures implemented. As the GDS estimates do include program administration and marketing costs, at least some of the costs of technical assistance visits can reasonably be assumed to be included in these values.

Based on an average for Gas DSM programs as used in evaluation of RCI-2, and derived from data in Tegen, S. and Geller, H., 2006. Natural Gas Demand-Side Management Programs: A National Survey, Southwest Energy Efficiency Project, www.swenergy.org. Should be replaced with sector- and/or NC-specific estimates when available.

Weighted average over total 2006-2010 electricity savings for this policy in each sector.

Other Data, Assumptions, Calculations	2010	2020/all	Units

Inputs to/Intermediate Results of Calculation of Electricity and Gas Savings

Residential Sector

Average energy consumption per household

Electricity	13.6	13.8	MWh
Natural Gas	18.0	18.3	MMBtu
LPG	7.2	7.3	MMBtu
Oil (Kerosene and Distillate Oil)	7.6	7.0	MMBtu

Average Savings from Application of Measures from Technical Assistance Visits

Electricity	20%
Other Fuels	20%
Average Fraction of Participants Installing Measures Following Visits	75%

Values above are rough estimates based on an aggressive program with significant incentives available. Average savings, however, are well within the range of those found (for example) in Greenville (NC) Utilities' longstanding (since 1977) residential survey/audit program, which frequently identifies savings potential for residential customers of up to 50 percent in overall energy use. Savings found commonly include building envelope and heating/cooling system measures, but also hot water system measures including simple plumbing fixes (personal correspondence with Andy Yakim of Greenville Utilities, 5/25/07).

Estimated Savings From Application of Measures (first-year savings, not cumulative)

Electricity	20.3	20.7	GWh
Natural Gas	27.0	27.4	Billion Btu
LPG	10.8	11.0	Billion Btu
Oil (Kerosene and Distillate Oil)	11.4	10.5	Billion Btu

Commercial Sector

Estimated Commercial-sector (Electricity) Customers

Based on estimate of future commercial square feet presented in RCI-3 (currently based on NC population growth).

Average energy consumption per commercial (electricity) customer

Electricity	77.1	89.5	MWh
Natural Gas	76.5	74.7	MMBtu
LPG	7.6	7.7	MMBtu
Oil (Kerosene and Distillate Oil)	24.7	20.3	MMBtu
Average Fraction of Participants Installing Measures Following Visits		75%	

Average Savings from Application of Measures from Technical Assistance Visits

Electricity	20%
Other Fuels	20%
Average Fraction of Participants Installing Measures Following Visits	65%

Average savings estimate is similar to average potential savings found in relatively extensive commercial-sector energy technical assistance programs. Achieved savings assumes provision of an aggressive program of services, and the availability of significant incentives to encourage participating consumers to adopt audit recommendations. By way of comparison, an technical assistance program for commercial and industrial customers carried out by Waste Reduction Partners (WRP) in Western North Carolina found potential energy savings from visits carried out in 2006 equal to 8.8 percent of total utility bills in businesses and institutions participating. The WRP program is staffed largely by volunteer retired engineers, and provides limited "energy audit" services (Terry Albrecht of WRP, personal communication). The fraction of participants assumed to install measures following visits reflects a combination of an aggressive program and the availability of substantial customer incentives, for example, from utility DSM programs, energy efficiency funds, or government lead-by-example programs.

Estimated Savings From Application of Measures (first-year savings, not cumulative)

Electricity	15.0	17.5	GWh
Natural Gas	14.9	14.6	Billion Btu
LPG	1.5	1.5	Billion Btu
Oil (Kerosene and Distillate Oil)	4.8	4.0	Billion Btu

Industrial Sector

Estimated Industrial-sector (Electricity) Customers

Average annual growth rate in customer numbers	-1.5%

Initial estimate--1999 to 2005 rate of change in industrial electricity customer numbers was -2.5%.

Average energy consumption per industrial (electricity) customer

Electricity	2,925.2	3,384.8	MWh
Natural Gas	2,362.8	2,717.8	MMBtu
LPG	2,627.3	3,385.3	MMBtu
Oil (Kerosene and Distillate Oil)	2,470.5	2,993.4	MMBtu

Average Savings from Application of Measures from Technical Assistance Visits

Electricity	20%
Other Fuels	20%
Average Fraction of Participants Installing Measures Following Visits	75%

Average savings estimate is similar to average potential savings found in relatively extensive industrial-sector energy technical assistance programs. Achieved savings and fraction of customers installing measures assumes provision of an aggressive program of services, and the availability of significant incentives to encourage participating consumers to adopt technical assistance recommendations.

Estimated Savings From Application of Measures (first-year savings, not cumulative)

Electricity	131.6	152.3	GWh
Natural Gas	106.3	122.3	Billion Btu
LPG	118.2	152.3	Billion Btu
Oil (Kerosene and Distillate Oil)	111.2	134.7	Billion Btu

Results	2010	2020	Units
Electricity Savings			
Reduction in Electricity Sales: Residential	61	267	GWh (sales)
Reduction in Electricity Sales: Commercial	45	208	GWh (sales)
Reduction in Electricity Sales: Industrial	389	1,813	GWh (sales)
TOTAL Reduction in Electricity Sales	495	2,288	GWh (sales)
Reduction in Generation Requirements	527	2,424	GWh (generation)
GHG Emission Savings	**0.46**	**1.73**	$MMtCO_2e$
Economic Analysis			
Net Present Value (2007-2020)		**-$316**	$million
Cumulative Emissions Reductions (2007-2020)		12.9	$MMtCO_2e$
Cost-Effectiveness		**-$24.52**	$/tCO_2e$
Natural Gas and Other Fuel Savings			
Reduction in Natural Gas Use: Residential	54	326	Billion BTU
Reduction in Natural Gas Use: Commercial	30	178	Billion BTU
Reduction in Natural Gas Use: Industrial	208	1,339	Billion BTU
TOTAL Reduction in Natural Gas Sales	**291**	**1,843**	Billion BTU
Reduction in LPG Use: Residential	22	131	Billion BTU
Reduction in LPG Use: Commercial	3	18	Billion BTU
Reduction in LPG Use: Industrial	228	1,562	Billion BTU
TOTAL Reduction in LPG Sales	**252**	**1,711**	Billion BTU
Reduction in Oil Use: Residential	23	133	Billion BTU
Reduction in Oil Use: Commercial	10	54	Billion BTU
Reduction in Oil Use: Industrial	216	1,429	Billion BTU
TOTAL Reduction in Oil Sales	**249**	**1,616**	Billion BTU
GHG Emission Savings	**0.05**	**0.32**	$MMtCO_2e$
Economic Analysis			
Net Present Value (2007-2020)		**-$179**	$million
Cumulative Emissions Reductions (2007-2020)		2.0	$MMtCO_2e$
Cost-Effectiveness		**-$87.34**	$/tCO_2e$

Summary Results for RCI-11	2010	2020	Units
Total for Policy (Electricity, Natural Gas and Other Fuels)			
GHG Emission Savings	0.51	2.05	$MMtCO_2e$
Net Present Value (2007-2020)		-$494	$million
Cumulative Emissions Reductions (2007-2020)		14.9	$MMtCO_2e$
Cost-Effectiveness		-$33.13	$/tCO_2e$

NOTES AND DATA FROM SOURCES

Note 1:

From The Energy Efficiency Task Force Report to the Clean and Diversified Energy Advisory Committee of the Western Governors Association.
The Potential for More Efficient Electricity Use in the Western United States, January, 2006. This report is referred to here as the "WGA CDEAC EE report" and can be found at:
http://www.westgov.org/wga/initiatives/cdeac/Energy%20Efficiency-full.pdf.

Estimate of Mitigation Option Costs and Benefits for North Carolina RCI GHG Analysis

Calculations based on Energy Efficiency Report by GDS Associates for NC Utilities Commission

Date Last Modified:	*2/12/2007*	*D. Von Hippel/A Bailie*

From A Study of the Feasibility of Energy Efficiency as an Eligible Resource as Part of a Renewable Portfolio Standard for the State of North Carolina. Dated 12/1/2006.
Report for the North Carolina Utilities Commission,
prepared and submitted by: GDS Associates, Inc.
Referred to below as the "GDS Report".

From page 10:
Table 1-5: Calculation of Cost per Lifetime kWh Saved by Sector for the RPS Energy Efficiency Scenario

	Present Value of Total Costs (2006 $)	Value of Lifetime kWh Savings - Customer Meter Level	Levelized Cost per Lifetime kWh Saved
Residential Sector	$262,528,658	9,673,701,174	$0.027
Commercial Sector	$352,185,339	8,702,321,930	$0.040
Industrial Sector	$124,388,270	6,805,459,342	$0.018
Total - All Sectors	$739,102,267	25,181,482,446	$0.029

For this RPS study for North Carolina, the initial levelized cost per lifetime kWh saved for each energy efficiency measure was calculated by calculating an annual installment loan payment to represent the annualized cost of the measure cost over its useful life, and then dividing this annualized cost by the first year kWh savings of the measure. This levelized cost per lifetime kWh saved for each energy efficiency measure can then be compared to the levelized cost of electric generation in North Carolina (including capital and operating costs). The levelized cost calculations shown in Table 1-5 include all costs, including program administration and financial incentives

The estimated cost, using CCS parameters is **$33.0** 2005$/lifetime MWh for the All Sectors weighted average levelized cost of energy savings. Making a proportional adjustement for individual sectors yields the following approximate adjusted costs for energy energy efficiency investments in each individual sector:

	Levelized Cost per Lifetime kWh Saved Adjusted for CCS Parameters
Residential Sector	$0.031
Commercial Sector	$0.046
Industrial Sector	$0.020

CCS calculations
Adjustments needed:
ensure total cost includes all customer costs
discount rates, GDS uses 10% (not sure if this is nominal), CCS uses 5% real
ensure total cost includes all customer costs
change from 2006$ to 2005$

Discount rate
adjust total costs to reflect CCS parameters for discount rate

GDS parameters		
	10.0%	nominal -- (as indicated at the bottom of table 1-4 of GDS Report)
	2.5%	annual inflation rate
	5.6%	Estimated annual line losses between the customer meter and the electric generation plant (page 147 of GDS Report)

CCS Parameter **5.0%** real discount rate

Adjusted Total Discounted Costs (2005$) **$831,297,957**
Adjusted total calculated from values in Table 1-4 of GDS report--see below.

Estimate of Mitigation Option Costs and Benefits for North Carolina RCI GHG Analysis

Background data on Green Power cost from "La Capra" Report

Date Last Modified:	*2/12/2007*	*D. Von Hippel/A Bailie*

Tables and Figures below are from ANALYSIS OF A RENEWABLE PORTFOLIO STANDARD FOR THE STATE OF NORTH CAROLINA, TECHNICAL REPORT, prepared by La Capra Associates for the North Carolina Utilities Commission, and dated December, 2006. Document available as http://www.ncuc.commerce.state.nc.us/rps/NC%20RPS%20Report%2012-06.pdf

We use figures from this report to estimate future net "Green Power" costs for use in RCI-9. Based on 10-year NPV data for the RPS Scenario "II. Expanded" to provide a 10 percent RPS by 2017, an average value for the net cost of RPS power per unit of renewable electricity generated is estimated as below:

Estimated sum of 10-year generation requirement above (read from Figure 5): 47,100 GWh
10-year net NPV of RPS (10% by 2017, scenario II) as indicated in Table 4, above:
$787 million
Implied average levelized net cost per MWh of RPS generation at 10% level, no EE
$16.71 /MWh

Figure 5

Projected RPS Energy Requirements

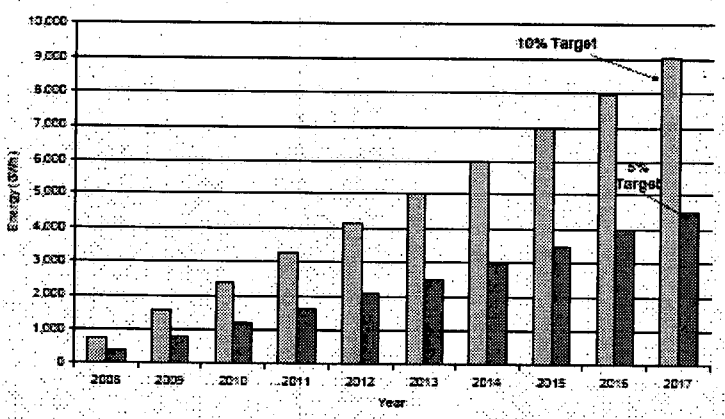


Table 14: Total Incremental Cost Over 10 Years in NPV

RPS Scenario	Resources	10-year NPV ($million) Utility Portfolio	Alternate Portfolio	Net Incremental Cost (with Marginal Energy)
5% by 2017	I. NCGP	$7,028	$7,646	$375
	II. Expanded		$7,484	$204
	III. Plus Energy Efficiency		$7,024	($95)
10% by 2017	I. NCGP		$8,983	$1,381
	II. Expanded		$8,281	$787
	III. Plus Energy Efficiency		$6,973	($177)

Appendix F
Energy Supply
Mitigation Option Recommendations

Summary List of Mitigation Options

	Mitigation Option Name	GHG Reductions ($MMtCO_2e$)			Net Present Value (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of Support*
		2010	2020	Total 2007–2020			
ES-1	Renewable Energy Incentives	0.01	0.04	0.33	15	45.1	UC
ES-2	Environmental Portfolio Standard						
ES-2a	Original analysis	6.94	44.3	288.7	1,634	5.7	UC
ES-2b	20% combined target	5.90	23.4	166.2	409.80	2.5	UC
ES-2c	Load growth offset target	5.53	22.3	160.3	393.95	2.5	UC
ES-3	Removing Barriers to CHP and Clean DG	0.69	2.8	20.1	127.98	6.4	UC
ES-4	CO_2 tax and/or Cap-and-Trade						
ES-4a	Electric sector only	0.84	3.3	20.4	119	5.8	SMJ
ES-4b	Economy-wide	1.84	7.1	47.7	284	6.0	SMJ
ES-5	Legislative Changes to Address Environmental and Other factors	Not quantified					UC
ES-6	Incentives for advanced coal						
ES-6a	Replacement of new 800 MW pulverized coal plant	0.00	3.9	31.0	949	30.6	UC
ES-6b	Replacement of Existing 800 MW Pulverized Coal plant	0.00	5.4	42.9	2,061	48.1	UC
ES-7	Public Benefit Charge	0.8	3.4	24.4	329	13.5	SMJ
ES-8	Waste to Energy	0.0	0.0	0.02	-0.7	-36.8	UC
ES-9	Incentives for CHP and Clean DG	Combined with ES–3					UC
ES-10	NC GreenPower Renewable Resources Program	0.01	0.2	0.95	35	37.0	UC
	SECTOR TOTAL AFTER ADJUSTING FOR OVERLAPS**	6.5	62.7	375	-5.9	-0.016	
	REDUCTIONS FROM RECENT ACTIONS (none)	0	0	0	0	0	
	SECTOR TOTAL PLUS RECENT ACTIONS**	6.5	62.7	375	-5.9	-0.016	

* UC = Unanimous Consent (all agree), SMJ = Super Majority (at least 80 percent or more agree).

** For ES-2, ES-4, and ES-6, emission reductions and costs associated with ES-2b, ES-4a, and ES 6a were used in the cumulative analysis.

ES-1. Renewable Energy Incentives (Biomass, Wind, Solar, Geothermal, Hydro)

Mitigation Option Description

This option focuses on financial incentives that promote the greater use of renewable energy. They are focused primarily for residents, businesses, and other end-users rather than for research and development, outreach, or inter-governmental programs. The effect of these incentives is to encourage investment in renewables by providing direct financial support.

Mitigation Option Design

Goals: Subsidy to renewable energy generators at 0.5 cents/kWh for each kWh of electricity generated from a qualifying renewable facility.

Timing: Tie into the timing of actions taken as a result of the NCUC RPS study. As a default, implement payments starting in 2008, and continuing through 2020.

Coverage of Parties: All power producers operating qualifying renewable facilities in North Carolina would receive the direct payments.

Other: Not applicable.

Implementation Mechanisms

The proposed implementation mechanism for this option is the direct payment mechanism. These represent direct subsidies for purchasing/selling renewable technologies given to buyer/seller. Other possible implementation mechanisms include a) tax credits or exemptions for purchasing/selling renewable technologies given to the buyer/seller, b) tax credits or exemptions for operating renewable energy facilities, c) feed-in tariffs which provide direct payments to renewable generators for each kWh of electricity generated from a qualifying renewable facility, and d) tax credits for each kWh generated from a qualifying renewable facility.

Related Policies/Programs in Place

NC GreenPower.

Type(s) of GHG Reductions

Renewable generation can reduce fossil fuel use in power generation and correspondingly reducing CO_2 emissions. To the extent that generation from coal and oil is displaced by renewables, black carbon emissions will decrease.

Estimated GHG Savings and Costs per $MtCO_2e$

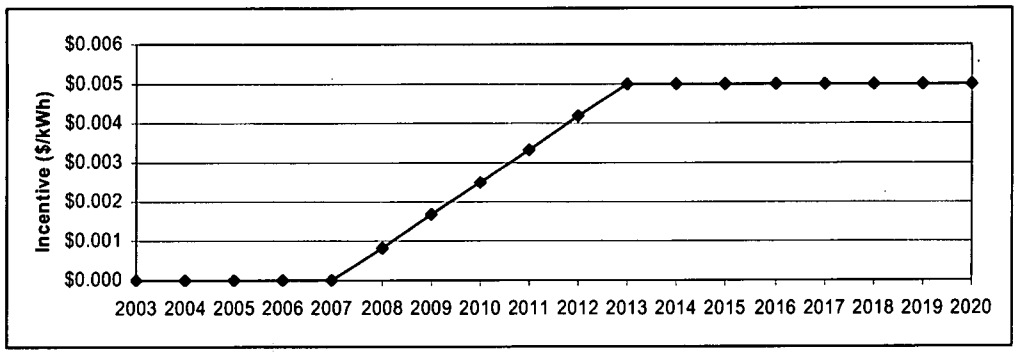
The table below summarizes the annual GHG reductions in 2010 and 2020, the cumulative GHG reductions through 2020, the incremental cost of the option (expressed in net present value terms), and the cost-effectiveness of the option (expressed in terms of $/tCO2e avoided).

Option #	Option Name	GHG Reductions (E6 tCO2e) 2010	2020	Total (2007–2020)	NPV of Costs (E6 2005$)	Cost of Saved Carbon (2005$/$tCO_2e$ avoided)
ES-1	Incentives for centralized renewables	0.01	0.04	0.33	$15	$45.1

NPV = net present value

- **Data Sources:** Energy Information Agency's (EIA's) Annual Energy Outlook (AEO) for 2006; "Clean Energy Technologies: A Preliminary Inventory of the Potential for Electricity Generation" by Owen Bailey and Ernst Worrell, LBNL-57451, April 2005.
- **Quantification Methods:** Ideally, one would undertake a full economic modeling exercise to assess the least cost mix/level of renewable energy, relative to North Carolina resource constraints and the incentives proposed. However, such an exercise would be both time-consuming and subject to very large uncertainties. Given time and budget limitations, an alternative analysis strategy was used that aimed to use previous analysis within a transparent spreadsheet structure. Hence, the completed analysis used a simple spreadsheet tool to assess the impact that financial incentives for centralized renewables would have on the penetration of renewable energy. The initial results of the Renewable Portfolio Standard (RPS) study under preparation in North Carolina will be reviewed for insights into a suitable renewable technology mix in the final of this report. The analysis involves the following steps:
  - Identify the type of renewable generation that would most likely be developed as a result of the EPS case combined with the financial incentives using a cost curve approach and taking into account renewable energy resources in North Carolina as noted in the LaCapra study and the fact that the RPS bill has passed;
  - Estimate the incremental costs associated with each type of renewable technology on a societal costs basis;
  - Estimate the incremental renewable generation resulting from the incentive on the basis of a comparison of the net program costs with and without the payments associated with the tax incentives.
  - Estimate the amount of CO_2 emissions that are expected to be avoided by the additional renewables resulting from the renewable energy incentives relative to the Reference Case.
- **Key Assumptions:** Where applicable, the key assumptions were the same as those used in analyzing the EPS. It is assumed that the renewables mix developed for the EPS was modified such that the renewables mix may be different relative to cost the competitiveness of these resources after the subsidies.
- **Analytical issues:** There were several assumptions that were made in quantifying the GHG reduction benefits and cost-effectiveness of this option, as follows:
  - *Amount of incentive:* As per guidance from the CAPAG, the maximum level of the incentive was set at $0.005/kWh (i.e., 0.5 cents/kWh) and was phased in per the schedule shown in Figure F-1.

Figure F-1. Proposed renewable energy incentive phase-in: 2007–2020



- *Renewable energy mix:* As per guidance from the TWG during the 19 December meeting, the recently completed RPS study[1] for the Public Utilities Commission was reviewed for renewable resource potential in North Carolina and compared with other sources. Resource potential in North Carolina from this study is summarized in Table F-1.

Table F-1. Estimated renewable energy potential in North Carolina

	Generation (GWh)		Share of total generation (%)	
Resource	Maximum	Practical	Maximum	Practical
Conventional hydropower	2,032	1,700	3%	11%
Geothermal	0	0	0%	0%
Hog waste	748	600	1%	4%
Co-firing	12,207	2,500	20%	17%
Dedicated biomass	20,661	6,200	34%	42%
Solar thermal	0	0	0%	0%
Solar photovoltaic	0	0	0%	0%
Wind (onshore)	24,960	3,900	41%	26%
Total	60,608	14,900	100%	100%

Note: shares of total generation are calculated relative to each estimate, whether maximum or practical. For example, the hydroelectric "practical" potential is 1,700 GWh, or 11% of the total practical potential

The resource shares in Table F-1 are considerably different from Energy Information Agency (EIA) estimates, which show mostly wind (81%) and the rest consisting of municipal waste (19%). Hence, the analysis was set up to consider three sensitivities, as follows:

1. LaCapra "practical": This corresponds to the practical assumptions in the RPS report. *Note that this was the default assumption.*
2. LaCapra "technical potential": This corresponds to the maximum assumptions in the RPS report.
3. EIA estimates for SERC: This corresponds to the EIA assumptions.

- *Levelized costs:* Levelized cost assumptions in 2020 are provided in Table F-2 for low, midrange, and high values.

[1] LaCapra Associates, 2006, *Analysis of a Renewable Portfolio Standard for the State of North Carolina*, December

Table F-2. Estimated levelized costs* of renewables (2005 $/MWh)

Resource	Low	Midrange (default)	High
Hydro	91.5	102	113.0
Wind	55.0	80	105.0
Solar PV	185.7	255	325.0
Hog waste	73.4	73	73.4
Poultry litter	73.4	73	73.4
Biomass cofiring in coal plants	4.5	12	19.9
Dedicated biomass combustion	82.6	99	115.1

*Constant level of annual revenue needed to recover all expenses over the life of a power-generating facility.

- *Avoided costs:* The RCI TWG calculated the avoided costs associated with electric sector expansion. Avoided costs were calculated starting with the levelized 15-year avoided costs from Duke Power, Progress Energy, and Dominion Resource Services price schedules for qualifying facilities purchased power, as filed in late 2005 with the NCUC (Docket No. E-100, Sub 100). Weighted average annual avoided costs were developed by application of estimated weighting factors for on-peak and off-peak usage, and for the fraction of North Carolina's electricity supplied by each of the three utilities. The implied utility-weighted average avoided cost was computed to be $57/MWh.
- *Marginal impact of renewable generation:* The introduction of new renewable generation associated with the incentive is assumed to displace generation from existing and/or new facilities. The analysis assumes that 50% of the generation displaced by the new renewable generation would be coal-fired and the balance natural gas-fired.

New renewable generation: It was assumed that the level of new renewable generation would be constrained, given the low level of the incentive. It was further assumed that the level of new generation would be less than the renewable generation levels in the Reference Case. The graphs in Figures F-2a and F-2b show the total incremental renewable generation assumed to come on line by the incentives between 2003 and 2020, as well as the new renewable generation mix in 2020.

Figure F-2a. Estimated renewable generation increase due to incentives

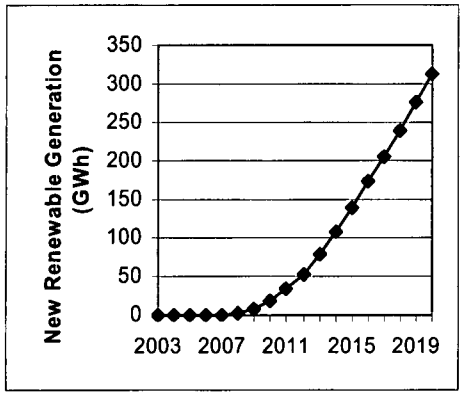
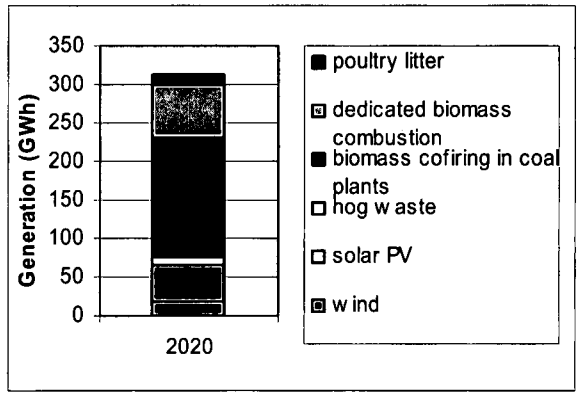


Figure F-2b. Projected mix of renewable generation: 2020

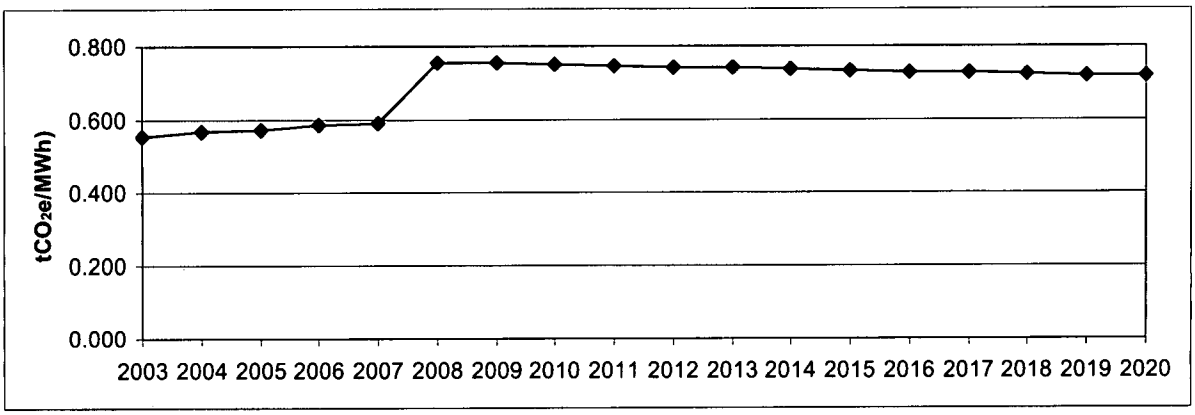


System CO_2e emission factor: The introduction of new renewable generation will lead to different reductions of greenhouse gases (GHG) depending upon whether the full fuel cycle is considered, or whether only GHG emissions are considered at the point of generation. Since it was unclear how the TWG would opt to proceed, the analysis was set up to consider two sensitivities, as follows:

1. Full fuel cycle emissions associated with electric supply. This assumes that upstream stages of the full fuel cycle (e.g., extraction, transport, or beneficiation) are considered the development of CO_2e emission factors. *Note that this is the default assumption and the results reflect this assumption.*
2. Emissions associated with electric generation only. This assumes that only the generation stage of the fuel cycle is considered the development of CO_2e emission factors.

Generation-specific average system emission factors were determined based on information developed in the NC Inventory and Forecast analysis. Full fuel cycle emission factors were determined based on US Department of Energy sources for upstream emissions. Figure F-3 shows the average emission factor associated with the generation displaced by new renewable generation.

Figure F-3. Average emission factor associated with generation displaced by new renewable generation



Long-term costs: The net present value costs of the incentives for each technology over the 2008–2020 period is summarized in Table F-3. These costs represent the level of the subsidy needed to achieve the associated generation.

Table F-3. Costs of renewables incentives: 2008–2020

Resource	NPV* (E6 2005$)
Hydro	$2.7
Wind	$5.7
Solar PV	$0.8
Biomass and waste	$11.9
Hog waste	$0.4
Poultry litter	$0.6
Biomass co-firing in coal plants	$0.9
Dedicated biomass combustion	$10.0
Total	**$21.2**

*NPV = net present value

- *Ancillary benefits:* There are a number of incentives that are worth noting. First, reductions in overall energy consumption and the shift from fossil fuel generation as a result of the incentives would lead to reductions in criteria air pollutants and, consequently, health costs associated with those pollutants. Second, the renewable generation promoted by the incentives, though small in magnitude, could nevertheless provide a fuel price hedge effect against fossil fuel price volatility, particularly natural gas in North Carolina. Finally, the operating costs of renewable generation, primarily maintenance, are generally spent locally and can provide a direct boost to local economies.

Rate impacts: A number of sensitivities were conducted to explore rate impacts associated with this mitigation option. Rate impacts were calculated in a three-step process as follows:

1. Determine displacement of fossil generation by energy efficiency and/or renewable generation,
2. Determine the incremental cost associated with this displacement; and
3. Calculate the rate impact by dividing the annual cost impact by total resulting retail electricity sales in North Carolina.

- A summary of rate impacts for each of the sensitivities is summarized in Table F-4.

Table F-4. Summary of rate impacts for six sensitivities

Option #	Option Name	GHG Reductions (E6 tCO2e)			NPV of Costs (E6 2005$)	Cost of saved Carbon (2005$/tCO2e avoided	2020 Rate Impact (2005 c/kWh)		
		2010	2020	Total 2007 – 2020			Energy Efficiency	Renewable Energy	Total
ES-1	Incentives for centralized renewables								
1	Original analysis (default assumptions)	0.01	0.04	0.33	$15	$45.1		0.0014	0.00143
2	Original analysis–low levelized cost estimate	0.02	0.08	0.68	($18)	($26.1)		0.0014	0.00143
3	Original analysis–high levelized cost estimate	0.01	0.03	0.23	$25	$108.3		0.0014	0.00143
4	Original analysis–CCS levelized cost estimate (2% solar PV set-aside)	0.01	0.04	0.32	$15	$47.9		0.0014	0.00143
5	Original analysis–low levelized cost estimate (2% solar PV set-aside)	0.02	0.08	0.67	($17)	($24.7)		0.0014	0.00143
6	Original analysis–high levelized cost estimate (2% solar PV set-aside)	0.01	0.03	0.23	$26	$112.4		0.0014	0.00143

NPV = net present value

Key Uncertainties

- North Carolina-specific costs of energy supply technologies modeled.
- Marginal impact of additional renewable generation on system dispatch in North Carolina.

Additional Benefits and Costs

- Introducing additional renewable generation also reduces emissions of local and regional air pollutants, such as sulfur and nitrogen oxides, which in turn reduce the human health and other impacts of those emissions.

Feasibility Issues

- Interaction with other programs to promote renewable energy.

Status of Group Approval

Completed.

Level of Group Support

Unanimous consent.

Barriers to Consensus

None.

ES-2. Environmental Portfolio Standard (Renewables and Energy Efficiency) with Renewable Energy Credit Trading

Mitigation Option Description

A renewable portfolio standard is a mitigation option requiring investor-owned electric utilities to supply a certain percentage of retail electricity from renewable energy sources by a stipulated date. An RPS that includes measurable, verifiable and lasting efficiency options is an Environmental Portfolio Standard (EPS). Utilities can satisfy the EPS requirement by generating renewable energy themselves or by purchasing renewable energy credits (REC) from a renewable energy generator. A REC is equal to 1 kWh of eligible and verified renewable electricity produced. North Carolina has recently passed such a bill by the General Assembly Of North Carolina in the 2007 Session.

Mitigation Option Design

Eligible renewable sources and energy efficiency applications are as briefly outlined in the paragraphs below:

Renewables: Solar PV; wind power; micro-hydropower (< 20MW); ocean current, tidal and wave energy; fuel cells using renewable fuels; and biomass including hog waste using an innovative waste management system that does not employ a lagoon, non-woody energy crops, wood wastes, anaerobically digested waste biomass, and other animal waste biomass.

Efficiency: applications that provide measurable, verifiable, long-term savings to the retail customer compared with current technology in use, including but not limited to appliances, HVAC, and efficient motors.

Goals: A 20% EPS by 2020, starting in 2008, with a minimum of 10% renewable generation by 2017. The RPS ramps up 1%/year over the 2008–2017 period.

Timing: as noted above.

Coverage of Parties: All power producers operating qualifying renewable facilities in North Carolina would participate.

Other: Not applicable.

Implementation Mechanisms

This is a command/control mitigation option requiring a legislative act by the North Carolina General Assembly, and/or mandated by the North Carolina Utilities Commission, within their jurisdiction.

Related Policies/Programs in Place

NC GreenPower and RPS Cost–Benefit Study.

Type(s) of GHG Reductions

Carbon dioxide from displaced coal, natural gas (NG) combined cycle and combustion turbine facilities; methane through the use of animal waste-to-energy and landfill gas-to-energy (LFGE) resources; and aerosols from displaced coal.

Estimated GHG Savings and Costs per $MtCO_2e$

The following three sensitivities were analyzed for the EPS:

- Original targets: this corresponds to a 31% combined energy efficiency and renewable energy target by 2020.
- 20% target: this corresponds to a 20% combined energy efficiency and renewable energy target by 2020.
- Load growth offset target: this corresponds to a % combined energy efficiency and renewable energy target by 2020 that offset load growth over that period.

For each of the above sensitivities, Table F-5 summarizes the annual GHG reductions in 2010 and 2020, the cumulative GHG reductions through 2020, the incremental cost of the option (expressed in net present value terms), and the cost-effectiveness of the option (expressed in terms of $ per ton of CO_2e).

Table F-5. Annual GHG reductions through 2020

Sensitivity	GHG Reductions (E6 tonnes CO_2e) 2010	2020	Total (2007–2020)	NPV of Costs (E6 2005$)	Cost of Saved Carbon (2005$/$tCO_2e$ avoided)
Original EPS analysis (default assumptions)	6.9	44.3	288.7	$1,634	$5.7
20% combined EPS target by 2020 (default assumptions)	5.9	23.4	166.2	$410	$2.5
Combined EPS target offsetting demand growth (default assumptions)	5.5	22.3	160.2	$394	$2.5

NPV = net present value

- **Data Sources:** EIA's Annual Energy Outlook (AEO) for 2006; "Clean Energy Technologies: A Preliminary Inventory of the Potential for Electricity Generation" by Owen Bailey and Ernst Worrell, LBNL-57451, April 2005; LaCapra Associates, 2006, "Analysis Of A Renewable Portfolio Standard For The State of North Carolina," December.
- **Quantification Methods:** The analysis used a simple spreadsheet tool to compare the aggregated costs and the efficiency and renewable components of the EPS scenario and will involve the following steps:
  - Identify the type of renewable generation that would most likely be used to meet the EPS' renewable energy targets of 10% by 2017 using a cost curve approach and taking into account the magnitude of renewable energy resources in North Carolina.
  - Identify the types of efficiency measures that to meet the EPS' energy efficiency targets by 2020 in coordination with the RCI TWG.
  - Estimate the incremental costs of the energy efficiency and renewable generation to meet the targets on a societal costs basis.

Estimate the amount of CO_2 emissions that are expected to be avoided by the renewables, relative to the reference case, from the EPS.

- **Key Assumptions:** The NC RPS is met with a combination of the resources as indicated under mitigation option design. Wind will likely represent a large share of the resources. The cost of renewable generation will include costs associated with connecting renewable technologies to the electric grid, and transmitting the renewable generation to loads.
- **Analytical issues:** Several assumptions were made in quantifying the GHG reduction benefits and cost-effectiveness of this option, as follows:
  - *Renewable energy mix:* See the discussion under ES-1. The same default assumptions were used.
  - *Levelized costs:* See the discussion under ES-1.
  - *Avoided costs:* See the discussion under ES-1.
  - *Marginal impact of energy efficiency and renewable generation:* The total level of projected electric generation displaced by the energy efficiency and renewable energy component of the EPS exceed total projected generation from load growth. This occurs in 2016. For this year onward, it was assumed that existing coal units that were built prior to the enactment of New Source Performance Standards in 1977 would be retired. It was assumed that these plants are fully depreciated and that incremental costs of the option should be calculated relative to their fuel and O&M costs only.

New renewable generation for the original target: The graphs in Figures F-4a and F-4b show the total incremental renewable generation assumed to come on line between 2003 and 2020, as well as the new renewable generation mix in 2020 for the original analysis (i.e., the 31% target).

Figure F-4a. Estimated renewable generation increase for the original analysis of the environmental portfolio standard

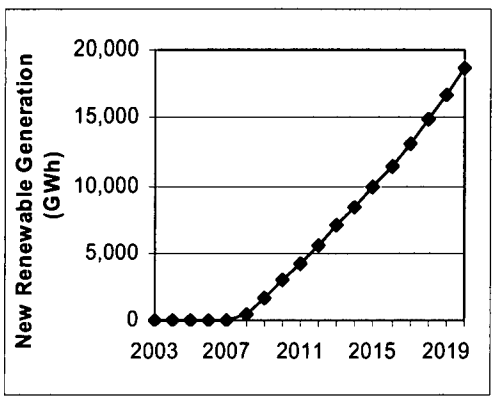
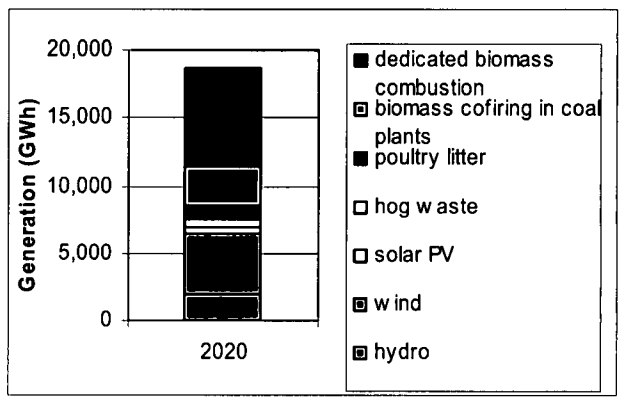


Figure F-4b. Projected mix of renewable generation for the original analysis of the environmental portfolio standard: 2020



New renewable generation for the 20% combined target: The graphs in Figures F-5a and F-5b show the total incremental renewable generation assumed to come on line between 2003 and 2020, as well as the new renewable generation mix in 2020 for the first sensitivity analysis (i.e., the 20% combined target).

Figure F-5a. Estimated renewable generation increase for the combined 20% target analysis of the environmental portfolio standard

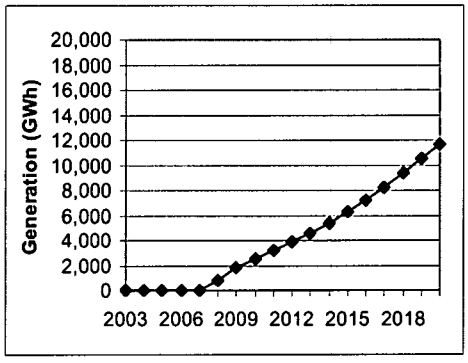
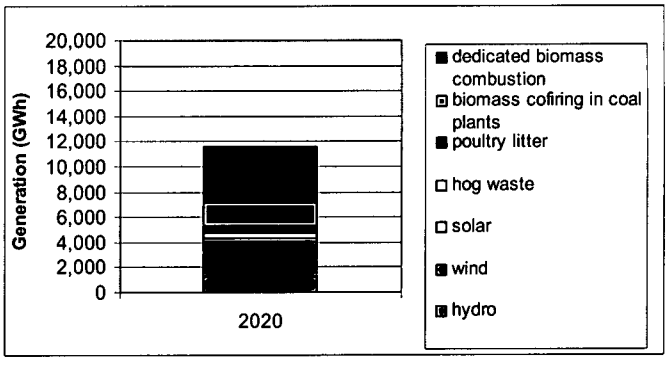


Figure F-5b. Projected mix of renewable generation for the combined 20% target analysis of the environmental portfolio standard: 2020



New renewable generation for the load growth offset target: The graphs in Figures F-6a and F-6b show the total incremental renewable generation assumed to come on line between 2003 and 2020, as well as the new renewable generation mix in 2020 for the second sensitivity analysis (i.e., the load offset target).

Figure F-6a. Estimated renewable generation increase for the load offset target analysis of the environmental portfolio standard

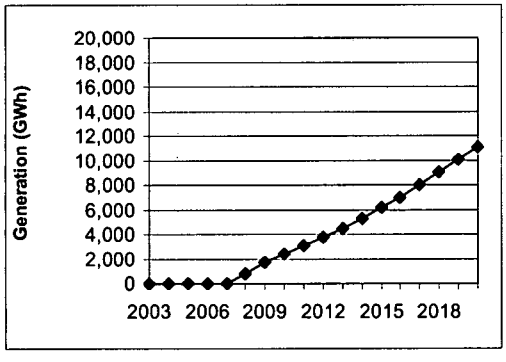
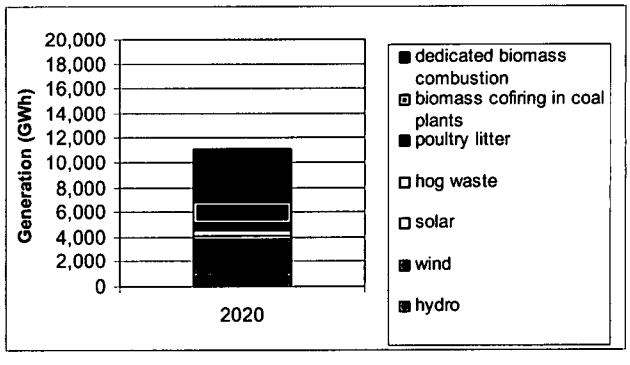
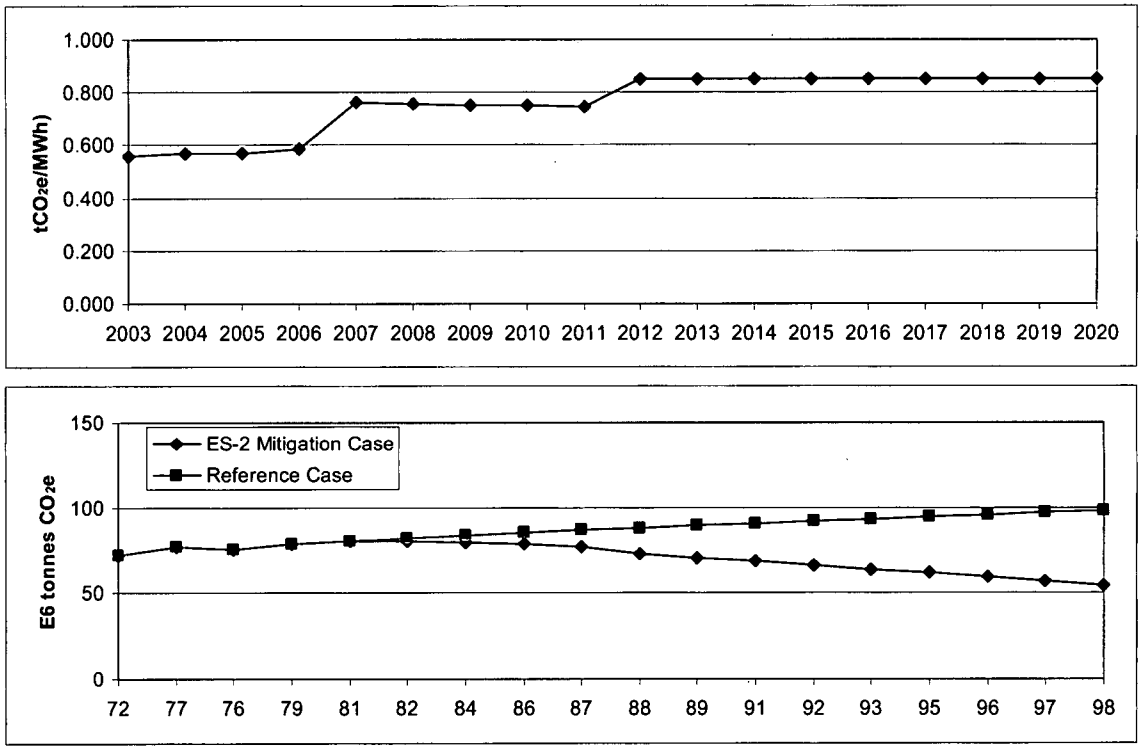


Figure F-6b. Projected mix of renewable generation for the load offset target analysis of the environmental portfolio standard: 2020



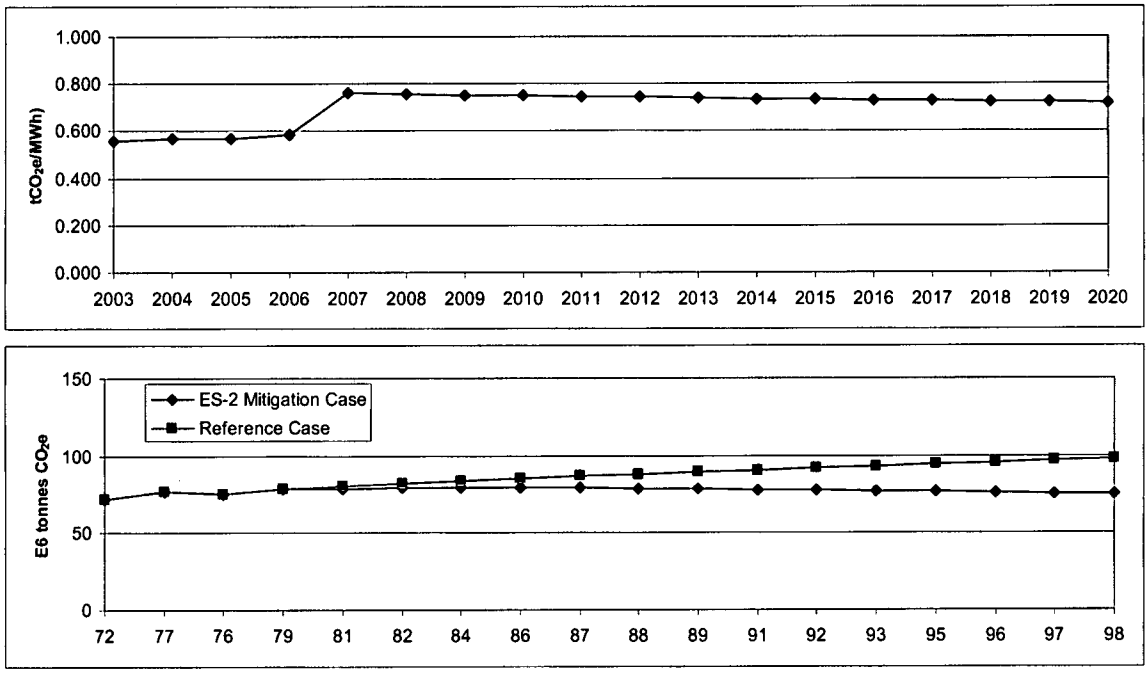
System CO_2e emission factor and emission reductions for the original target: The top graph in Figure F-7 shows the average emission factor associated with resources displaced under default assumptions for the EPS option. The bottom graph in Figure F-7 shows annual CO_2e emissions from North Carolina's electric sector before and after the introduction of the EPS.

Figure F-7. Top = Average emission factor with resources displaced with original EPS target; Bottom = Annual CO_2e emissions from electric sector before and after original EPS.



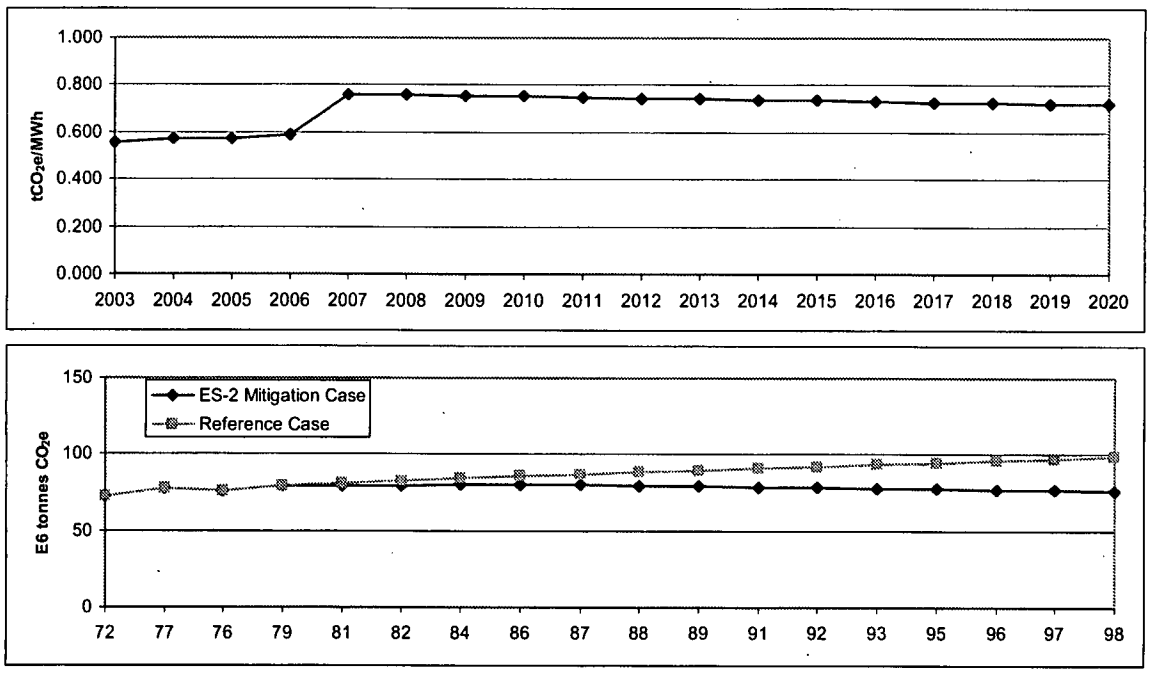
System CO_2e emission factor and emission reductions for the 20% combined target: The top graph in Figure F-8 shows the average emission factor associated with resources displaced under the assumption of a lower EPS target relative to the original analysis. The bottom graph in Figure F-8 shows annual CO_2e emissions from North Carolina's electric sector before and after the introduction of the revised EPS.

Figure F-8. Top = Average emission factor with resources displaced with 20% combined EPS target;
Bottom = Annual CO_2e emissions from electric sector before and after 20% combined EPS.



System CO_2e emission factor and emission reductions for the load growth offset target: The top graph in Figure F-9 shows the average emission factor associated with resources displaced under the assumption of an even lower EPS target relative to the original analysis. The bottom graph in Figure F-9 shows annual CO_2e emissions from North Carolina's electric sector before and after the introduction of the revised EPS.

Figure F-9. Top = Average emission factor with resources displaced with load growth offset EPS target;
Bottom = Annual CO_2e emissions from electric sector before and after load growth offset EPS target.



Rate impacts: A number of sensitivities were conducted to explore rate impacts associated with this mitigation option. See the discussion under ES-1 for the method used to calculate rate impacts. A summary of rate impacts for each of the sensitivities is shown in Table F-6. Under default assumptions (i.e., central cost inputs), rate impacts range from 0.095 cents/kWh to 0.189 cents per kWh. Under the high cost input assumptions with solar PV set asides, rate impacts range from 0.110 cents/kWh to 0.22 cents per kWh. Under the low cost input assumptions with solar PV set asides, rate impacts range from 0.086 cents/kWh to 0.171 cents per kWh.

Table F-6. Summary of rate impacts for each sensitivity

Option #	Option Name	GHG Reductions (E6 tCO2e)			NPV of Costs (E6 2005$)	Cost of Saved Carbon (2005$/t CO_2 avoided	2020 Rate Impact (2005 c/kWh)		
		2010	2020	Total (2007–2020)			Energy Efficiency	Renewable Energy	Total
ES-2a	**ES-2 Environmental Portfolio Standard**								
1	Original analysis (default assumptions)	6.94	44.33	288.73	$1,634	$5.7	0.075	0.113	0.1888
2	Original analysis–low levelized cost estimate	6.94	44.33	288.73	$43	$0.1	0.075	0.092	0.1671
3	Original analysis–high levelized cost estimate	6.94	44.33	288.73	$3,224	$11.2	0.075	0.135	0.2105
4	Original analysis–CCS levelized cost estimate (2% solar PV set-aside)	6.94	44.33	288.73	$1,847	$6.4	0.075	0.119	0.1939
5	Original analysis–low levelized cost estimate (2% solar PV set-aside)	6.94	44.33	288.73	$191	$0.7	0.075	0.095	0.1707
6	Original analysis–high levelized cost estimate (2% solar PV set-aside)	6.94	44.33	288.73	$3,504	$12.1	0.075	0.142	0.2172
ES-2b	**EPS—20% combined target by 2020**								
1	20% target analysis (default assumptions)	5.90	23.37	166.20	409.80	2.47	0.042	0.064	0.1063
2	20% target analysis–low levelized cost estimate	5.90	23.37	166.20	-645.54	-3.88	0.042	0.052	0.0941
3	20% target analysis–high levelized cost estimate	5.90	23.37	166.20	1,465.15	8.82	0.042	0.076	0.1185
4	20% target analysis–CCS levelized cost estimate (2% solar PV set-aside)	5.90	23.37	166.20	552.85	3.33	0.042	0.067	0.1092
5	20% target analysis–low levelized cost estimate (2% solar PV set-aside)	5.90	23.37	166.20	-546.29	-3.29	0.042	0.054	0.0960
6	20% target analysis–high levelized cost estimate (2% solar PV set-aside)	5.90	23.37	166.20	1,651.98	9.94	0.042	0.080	0.1223
ES-2c	**EPS—combined target offsetting demand growth**								
1	demand growth offset analysis (default assumptions)	5.53	22.29	160.25	393.95	2.46	0.037	0.058	0.0951
2	demand growth offset analysis–low levelized cost estimate	5.53	22.29	160.25	-623.56	-3.89	0.037	0.047	0.0840
3	demand growth offset analysis–high levelized cost estimate	5.53	22.29	160.25	1,411.46	8.81	0.037	0.069	0.1061
4	demand growth offset analysis–CCS levelized cost estimate (2% solar PV set-aside)	5.53	22.29	160.25	531.87	3.32	0.037	0.060	0.0976
5	demand growth offset analysis–low levelized cost estimate (2% solar PV set-aside)	5.53	22.29	160.25	-527.86	-3.29	0.037	0.048	0.0858
6	demand growth offset analysis–high levelized cost estimate (2% solar PV set-aside)	5.53	22.29	160.25	1,591.60	9.93	0.037	0.072	0.1095

NPV = net present value

Solar thermal: The ES TWG has opted to include solar thermal results in its results. This is in contrast to the approach adopted thus far to include these results as part of the RCI TWG results. Table F-7 shows the costs and benefits of solar thermal technology as computed from the penetration targets used in the RCI TWG.

Table F-7. Costs and benefits of solar thermal technology

Option #	Option Name	GHG Reductions (E6 tonnes CO_2e) 2010	2020	Total (2007–2020)	NPV of Costs (E6 2005$)	Cost of Saved Carbon (2005$/t$CO_2e$ avoided)
RCI-3	Solar thermal hot water/space heat/space cooling for government sector (Energy Efficiency Requirements for Government Buildings)	0.00	0.10	0.20	$3.44	$16.89
RCI-7	Solar thermal hot water/space heat/space cooling for commercial/residential (Beyond Code—Building Design Incentives and Targets, Incorporating Local Building Materials and Advanced Construction)	0.02	0.15	0.33	$7.94	$23.84
RCI-10	Solar hot water for residential sector (Distributed Renewable and Clean Fossil Fuel Power Generation)	0.04	0.21	0.80	$35.35	$43.98

NPV = net present value

Key Uncertainties

- North Carolina-specific costs of energy supply technologies modeled.
- Marginal impact of energy efficiency and renewable generation on system dispatch in North Carolina.

Additional Benefits and Costs

Introducing additional renewable generation also reduces emissions of local and regional air pollutants, such as sulfur and nitrogen oxides, which in turn reduce the human health and other impacts of those emissions.

Feasibility Issues

- Interaction with other programs to promote renewable energy and energy efficiency.

Status of Group Approval

Completed.

Level of Group Support

Unanimous Consent.

Barriers to Consensus

None.

ES-3 and ES-9. Removing Barriers and Providing Incentives to Combined Heat and Power (CHP) and Clean DG

Mitigation Option Description

Combined Heating Cooling and Power (CHP), also know as cogeneration, is a method of utilizing the thermal energy (heat) produced when generating electricity (power) in a single, coordinated process. CHP is more energy efficient than separate generation of electricity at a separate central electric plant and production of localized thermal energy for the end user. This distributed generation resource allows for recycling the heat, which is normally wasted to cooling towers or lakes at centralized electric generating stations, to meet onsite thermally driven demand such as process and space heating, cooling and dehumidification.

Mitigation Option Design

The proposed mitigation option encourages adoption of CHP through a combination of regulatory improvements and expanded incentives designed to improve interconnection and net metering standards, adopt output based emission standards, and allow GHG friendly business arrangements, such as third party ownership of CHP based generation.

Goals: 50% of North Carolina's 4,000 MW of planned new electric generation will be CHP.

Timing: Goal should be achieved by 2018, within the time frame for new generation additions.

Coverage of Parties: NC Utilities Commission, Utilities, NC Sustainable Energy Assoc.

Other: Not applicable.

Implementation Mechanisms

This is a command and control mitigation option that would be implemented with the following steps: 1) Encourage CHP systems of 20 MW or smaller (or of equivalent mechanical power) by a speedy adoption and customer friendly implementation of FERC Order 2006 Standardization of Small Generator Interconnection Agreements and Procedures, 2) Qualify recycled energy from CHP generation for existing renewable and energy efficiency incentive and loan programs, 3) Allow energy service companies to sell CHP and CDG output to third party customers, and 4) Facilitate governmental and non profit organizations to easily sell renewable energy credits and tax credits to the market place.

Related Policies/Programs in Place

The mitigation option design statements point to key related policies and programs which already exist in North Carolina, at the national level and other states such as Connecticut, New York, Texas, and California for successfully implementing CHP and CDG.

Type(s) of GHG Reductions

Substantial carbon dioxide reductions would be achieved from displaced coal generation.

Estimated GHG Savings and Costs per $MtCO_2e$

The table below summarizes the annual GHG reductions in 2010 and 2020, the cumulative GHG reductions through 2020, the incremental cost of the option (expressed in net present value terms), and the cost-effectiveness of the option (expressed in terms of $ per ton of CO_2e avoided).

Option #	Option Name	GHG Reductions (E6 tonnes CO_2e)			NPV of Costs (E6 2005$)	Cost of Saved Carbon (2005$/$tCO_2e$ avoided)
		2010	2020	Total (2007–2020)		
ES-3 & ES-9	CHP incentives and barrier removal	0.7	2.8	20.1	$128	$6.4

NPV = net present value

- **Data Sources:** EIA's Annual Energy Outlook (AEO) for 2006; *Combined Heat and Power White Paper*, dated January, 2006, prepared for the Clean and Diversified Energy Initiative of the Western Governors Association based on a study in 2003 for NREL by Energy and Environmental Analysis
- **Quantification Methods:** The proposed analysis will use a simple spreadsheet tool to evaluate the costs and benefits associated with introducing 2,000 MW over the study period. It will involve the following steps
  - The starting point for the analysis was to develop a better understanding of the CHP in North Carolina, based on a review of available studies. This helped to confirm a key assumption of the analysis that there exists at least 2,000 MW of CHP potential by 2020, as well as identify a working split between commercial and industrial CHP.
  - Integrate assumptions regarding the penetration of and fuel shares for new CHP systems, estimates of future capacity of CHP developed under the mitigation option, and CHP cost and performance for different kinds of systems into a spreadsheet model to estimate the overall net GHG emissions reduction and net cost of the mitigation option. The avoided GHG emissions will be estimated in a manner consistent with the analysis of demand reduction options in RCI.
- **Key Assumptions:** A key assumptions is that CHP potential is at least 2,000 MW, and can be phased in at an acceptable rate. Systems are assumed to operate an average of 5,000 hours/year (at full capacity), and 90% of co-generated heat is assumed to be usable (and displaces heat from purchased fuels). Gas-fired, biomass-fired, and coal-fired capacity are assumed, with a mix that includes a heavy reliance on natural gas.
- **Analytical Issues:** There were several assumptions that were made in quantifying the GHG reduction benefits and cost-effectiveness of this option, as follows:

CHP targets: The CAPAG indicated that a sensitivity analysis should be conducted regarding the level of penetration of CHP systems. Hence, the analysis was set up to consider the following sensitivities.

1. 50% of the target is met: This corresponds to 1,000 MW of new CHP capacity.

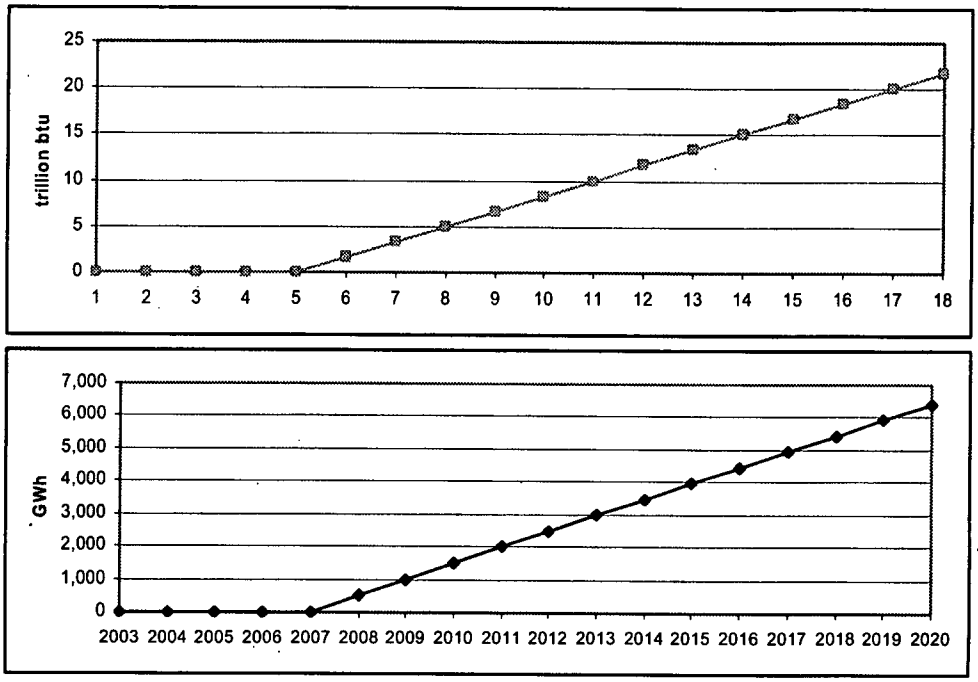
   Note that this is the default assumption and the results reflect this assumption.

2. 90% of the target is met: This corresponds to 1,800 MW of new CHP capacity.

- *Fuel mix:* It was assumed that the fraction of new CHP capacity fueled with NG was 90%, with the remaining 10% split evenly between biomass and coal.

Energy and system electricity displaced by CHP: CHP electric production characteristics as well and system transmission and distribution (T&D) losses were accounted for to estimate annual fuel and system electric generation displaced, as shown in Figure F-10.

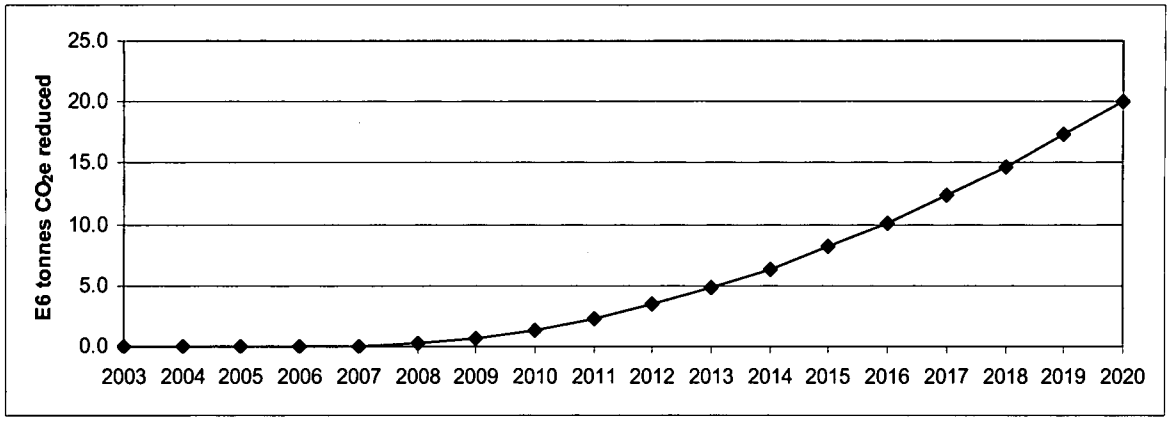
Figure F-10. Top = Net displaced fuel use after accounting for net efficiency
Bottom = Electricity generation from CHP facilities



- *Marginal impact of CHP:* See the discussion under ES-1. The same default assumptions were used.

CO_2-e emission factor and cumulative emission reductions: See the discussion under ES-1 for electric supply. The same default assumptions were used. For fuel, standard IPCC emission factors were used for natural gas, coal, biomass, and oil. Figure F-11 shows cumulative CO_2e emission reductions associated with CHP systems.

Figure F-11. Cumulative CO_2e emission reductions with CHP systems



Key Uncertainties

- CHP potential in North Carolina.
- Heating fuels to be displaced by cogeneration
- Future cost and performance characteristics of CHP systems.

Additional Benefits and Costs

- Reduction of losses associated with T&D.

Feasibility Issues

- Interconnection with electric system grid.

Status of Group Approval

Completed.

Level of Group Support

Unanimous consent.

Barriers to Consensus

None.

ES-4. CO_2 Tax and/or Cap-and-Trade (Covering Sources Including Fossil, Renewable, and Nuclear on Life Cycle Basis)

Mitigation Option Description

A cap and trade system is a market mechanism in which CO_2 and other GHG emissions are limited or capped at a specified level, and those participating in the system can trade permits (a permit is an allowance to emit one ton of CO_2 and GHG) in order to lower costs of compliance. For every ton of CO_2 and GHG released, an emitter must hold a permit. Therefore, the number of permits issued or allocated is, in effect, the cap. The government can give permits away for free (according to any one of many different criteria to those participating in the cap and trade system or even to those who are not), auction them, or a combination of the two. Participants can range from a small group within a single sector to the entire economy and can be implemented upstream (at the level of fuel extraction or import) or downstream at the points where fuel is consumed.

Mitigation Option Design

A cap and trade program applicable to North Carolina sources would be implemented on a national or regional (i.e., multi-state) basis. A program covering the power sector alone was analyzed. It is important to note that the purpose of assessing a cap and trade program within the TWG process is to consider the GHG reductions and costs (or cost savings) of such a mitigation option, not to define the details of a prospective regulatory program.

Goals: GHG intensity reduction of about 2%/year over the 2010–2020 period.

Timing: Program start-up in 2008.

Coverage of Parties: NC Utilities Commission, Utilities.

Other: Not applicable.

Implementation Mechanisms

This is a market-based mechanism with an underlying regulatory obligation.

Related Policies/Programs in Place

No cap and trade system is in place in North Carolina.

Type(s) of GHG Reductions

A cap and trade system will impose a direct limit on CO_2 emissions. Reductions are determined by the level of the cap. To the extent that generation from coal and oil declines under a cap and trade system, black carbon emissions will also decrease.

Estimated GHG Savings and Costs per $MtCO_2e$

The table below summarizes the annual GHG reductions in 2010 and 2020, the cumulative GHG reductions through 2020, the incremental cost of the option (expressed in net present value terms), and the cost-effectiveness of the option (expressed in terms of $ per ton of CO_2e avoided).

Option #	Option Name	GHG Reductions (E6 tonnes CO_2e) 2010	2020	Total (2007–2020)	NPV of Costs (E6 2005$)	Cost of Saved Carbon (2005$/$tCO_2e$?] avoided)
ES-4	Cap GHG and trade					
	Electric sector only	0.8	3.3	20.4	$119	$5.81
	Economy-wide	1.8	7.1	47.7	$284	$5.95

NPV = net present value

- **Data Sources:** EIA report (see below).
- **Quantification Methods:** A parameterization approach was used to assess this mitigation option. This is due to the fact that the analysis of a cap and trade system in North Carolina would be highly complex involving sophistical modeling techniques and difficult to do well given time and resource constraints. The parameterization techniques involve the downscaling of results of the GHG cap-and-trade study done by the Energy Information Administration (EIA) in a Congressional Service Report from March 2006 titled *"Energy Market Impacts of Alternative Greenhouse Gas Intensity Reduction Goals"* based on the use of the National Energy Modeling system model (NEMS) based on the Annual Energy Outlook of 2006. This is an updated analysis of an earlier EIA report titled: *"Impacts of Modeled Recommendations of the National Commission on Energy Policy"* dated April 2005 which had been prepared by the EIA using the Annual Energy Outlook of 2005 in response to a request from Senator Jeff Bingaman, ranking Minority Member of the U.S. Senate Committee on Energy and Natural Resources, to assess the impact of, among others, a GHG cap-and-trade policy for the USA.
- **Key Assumptions:** The EIA study is a national study, which can be downscaled for application to North Carolina using parameterization techniques.
- **Analytical Issues:** There were several assumptions that were made in quantifying the GHG reduction benefits and cost-effectiveness of this option, as follows:
  - *Analysis cases:* As per direction from the CAPAG, the ES TWG considered two cases. The first case assumes that a cap (expressed as a carbon intensity per unit of economic output) is placed only on the electric sector. The second case assumes that a cap (expressed as a carbon intensity per unit of economic output) is placed on the electric and demand sectors.

Scenarios analyzed: The analysis upon which the parameterization is based considered the following four scenarios:

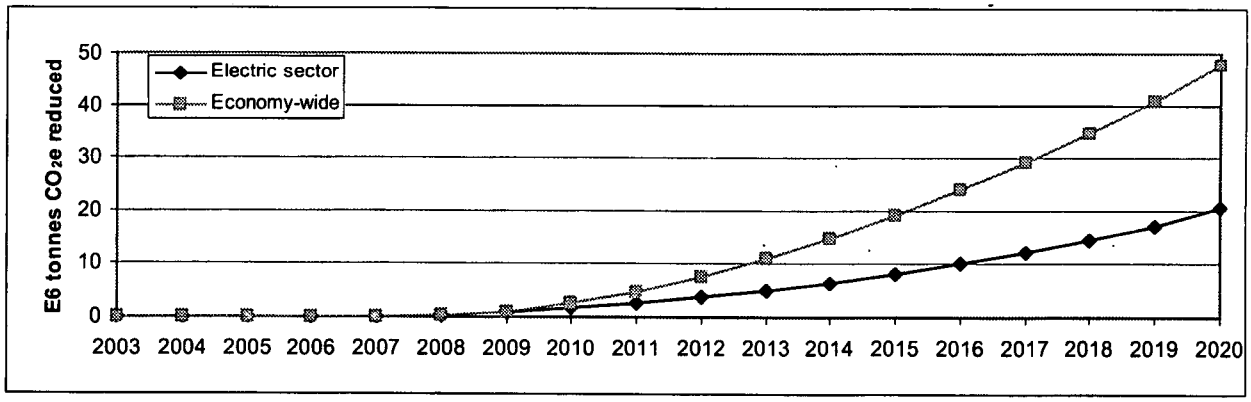
1. *Cap & trade #1:* This assumes a GHG intensity (tCO_2/$ of output) reduction of 2.4%/year, economy-wide, between 2010 and 2019. The trading price is $6.16/$tCO_2e$ and $9.86/$tCO_2e$ in 2010 and 2020, respectively. *Note that this is the default assumption and the results reflect this assumption.*

2. *Cap & trade #2:* This assumes a GHG intensity reduction of 2.6%/year between 2010 and 2019. The trading price is \$8.83/tCO_2e and \$14.13/tCO_2e in 2010 and 2020, respectively.
3. *Cap & trade #3:* This assumes a GHG intensity reduction of 2.8%/year between 2010 and 2019. The trading price is \$22.09/tCO_2e and \$35.34/tCO_2e in 2010 and 2020, respectively.
4. *Cap & trade #4:* This assumes a GHG intensity reduction of 3.0%/year between 2010 and 2019. The trading price is \$30.92/tCO_2e and \$49.47/tCO_2e in 2010 and 2020, respectively.

- *Parameterization approach:* It was assumed that a national cap-and-trade system had been implemented as per the EIA analysis. The aim of the parameterization is to extract the impact on North Carolina from the application of this national policy. A simple scaling from the national to the state level was performed based on the percent GHG reductions from the Reference Case. Total costs of the mitigation option were calculated on the basis of the GHG reduction achieved in North Carolina and the national credit price.

CO2e cumulative emission reductions: Figure F-12 shows cumulative CO_2e emission reductions in the North Carolina electric sector and economy-wide associated with the cap & and trade option.

Figure F-12. Cumulative CO_2e emission reductions in electric sector and economy-wide with cap & trade option



Rate impacts: A number of sensitivities were conducted to explore rate impacts associated with this mitigation option. See the discussion under ES-1 for the method used to calculate rate impacts.

The sensitivity analyses are associated with the safety valve price (i.e., the safety-valve is an agreement by the government to sell emission permits at a given price so as to limit the potential permit cost to a maximum. The government is assumed to sell permits sufficient to make up the difference between covered emissions and the emissions goal. As a result, the government begins to accrue additional permit revenue once the safety-valve price is reached). A summary of rate impacts for each of the sensitivities is as presented in Table F-8.

Table F-8. Summary of rate impacts for each sensitivity

Option #	Option Name	2020 Rate Impact (2005 c/kWh)		
		Energy Efficiency	Renewable Energy	Total
ES-4	**Cap GHG and Trade–Electric Sector Only**			
	Safety valve price trajectory #1			0.0038
	Safety valve price trajectory #2			0.0085
	Safety valve price trajectory #3			0.0577
	Safety valve price trajectory #4			0.1139
ES-4	**Cap GHG and Trade–Economy-wide**			
	Safety valve price trajectory #1			0.0035
	Safety valve price trajectory #2			0.0078
	Safety valve price trajectory #3			0.0579
	Safety valve price trajectory #4			0.1201

Key Uncertainties

North Carolina–specific impacts of a national cap-and-trade system.

Additional Benefits and Costs

An economy wide cap-and-trade system would achieve substantially higher GHG reductions at a small incremental cost.

Feasibility Issues

Allowance allocation and other design issues.

Status of Group Approval

Completed.

Level of Group Support

Supermajority of Support (two objections).

Barriers to Consensus

Resolution of the coverage issues (i.e., desirability of a national vs. a state-specific cap-and-trade system).

ES-5. Aligning Environmental and Profit Incentives Through Electric Sector Regulatory/Rate Reform

Mitigation Option Description

Several regulatory and rate reforms in North Caroline would encourage electric utilities to invest in clean, non-carbon-producing energy resources such as renewables and energy efficiency. Under the current rate structure, utilities have an incentive to invest in new large capital projects, which also may inhibit investments in energy efficiency. North Carolina could align the regulated electric utilities' profit motive with increased energy efficiency by removing perverse disincentives to energy efficiency.

Mitigation Option Design

Aligning environmental and profit incentives could be accomplished by action on the part of the Utilities Commission to reform the rate structure through a) decoupling profits from sales volume, b) making lost revenue adjustments, and developing inverted block rates. Moreover, the Utilities Commission should require electric utilities to consider the costs associated with future regulation of carbon dioxide emissions when evaluating both supply-side (e.g., new power plants) and demand-side (e.g., energy efficiency) resource options. Aligning environmental and profit incentives in North Carolina would involve the following:

- *Decoupling Profits from Sales*—In a decoupled rate structure, utility profits are based on their cost of service and number of customers, rather than electricity sales. Utilities are entitled to earn enough revenue to cover fixed costs plus some profit based on their projected sales. If sales exceed projections, excess revenue is returned to ratepayers through rate adjustments the following year. If sales are lower than projection, rates are increased the following year to make up the difference.
- *Lost Revenue Adjustment*—Lost revenue adjustments reward utilities for energy generation lower than anticipated levels and remove additional profits when utility generation is higher than anticipated levels. This is accomplished by allowing utilities to recover net revenues lost due to energy efficiency programs (including decreased sales plus the administrative costs of the program) via periodic rate adjustments. Thus, the incentive for ever-increasing electricity sales is removed *and* efficiency is rewarded.
- *Inverted Block Rates for Residential Customers*—Inverted block rates, in which rates increase with consumption, can encourage efficiency for residential customers by sending customers price signals that more accurately reflect the costs of producing electricity. Because each successive "block," or increment of energy used per billing period becomes progressively more expensive, inverted block rates encourage efficiency and discourage wasteful consumption. Inverted block rates can also better serve families with low incomes.
- *Require Utilities to Use a "Carbon Adder" in Resource Selection*—"Carbon adders" are a means of accounting for possible future costs of compliance with future GHG regulations. A carbon adder is an expected future price for CO_2 that is assumed when

comparing resource options. It typically involves that utilities include in the resource selection and screening process a CO_2 cost adder.

Goals: This mitigation option will not be quantified in the analysis phase, as it is too early in the process to assign goal levels. Instead, the emphasis during the analysis phase will be to define the details of a prospective rate reform program. After this process, it may be possible to assign goal levels in some future initiative.

Timing: TWG develops the initial details of a prospective rate reform program (October 2006–February 2007) and present this as an output of the NC Climate Change mitigation process. New legislation, based on the results of studies by the NC Utilities Commission and the NC legislature, would set the start year for implementation of reforms to be 2009.

Coverage of Parties: Utilities Commission, regulated electric utilities, State Energy Office, environmental and public health groups

Other: Not applicable.

Implementation Mechanisms

This is a command/control options that requires changes to Utilities Commission rules and/or legislation by the General Assembly.

Related Policies/Programs in Place

Numerous other states have similar rate reform programs in place.

Type(s) of GHG Reductions

Greater reliance on renewables and energy efficiency would reduce dependence on electricity produced by burning coal and other fossil fuels, thereby reducing emissions of carbon dioxide and other greenhouse gases.

Estimated GHG Savings and Costs per $MtCO_2e$

- **Data Sources:** Not applicable.
- **Quantification Methods:** Not applicable.
- **Key Assumptions:** Not applicable.

Key Uncertainties

Interaction with other options.

Additional Benefits and Costs

Aligning environmental goals with planning protocols would reduce emissions of local and regional air pollutants and land/water impacts.

Feasibility Issues

Interaction with other programs to promote environmental quality.

Status of Group Approval

Completed.

Level of Group Support

Unanimous consent.

Barriers to Consensus

None.

ES-6. Incentives for Advanced Coal

Mitigation Option Description

Integrated gasification combined cycle (IGCC) is an emerging technology for coal power, offering the potential for higher efficiency and reduced cost of pollutant emissions control. IGCC involves partially combusting coal under high pressure to produce a synthetic gas, which is then turned into electricity via combined cycle combustion. IGCC can be combined with carbon capture and sequestration or reuse (CCSR) leading to significant CO_2 emission reductions relative to those of conventional coal technology. This technology appears to be limited only by some cost differences at this time. However, due to locations of coal sources and suitable sequestration sites, additional analysis of how this can be made viable in North Carolina is anticipated.

Mitigation Option Design

Options for advanced fossil technologies may include mandates or incentives to use advanced coal technologies for new coal plants. Mandates could take multiple forms such as a) certain CO_2 emission rates only achievable with advanced technology, b) specifying that new coal plants be Integrated Gasification Combined Cycle (IGCC), or c) requiring that a certain percentage of new coal plants be IGCC or employ advanced fossil technologies. Incentives may be in the form of direct subsidies or assistance in securing financing. A combination of mandates and incentives is also possible.

Goals: At least one new IGCC power plant in North Carolina replacing a planned conventional coal addition. This goal would be reached by confirmation of technical feasibility in North Carolina and then providing an incentive equal to the marginal cost difference between conventional coal technology and new advanced coal technology (with carbon capture/sequestration as appropriate), currently equal to about a 20%–25% premium above the cost of pulverized coal plants. Utilities would be assured cost recovery regardless of whether the system includes carbon capture/storage.

Timing: Program start-up as soon as possible. Tie into CPCN proceeding, where details regarding cost estimates and the incentive program can be developed.

Coverage of Parties: NC Utilities Commission, NC-based Utilities

Other: Not applicable.

Implementation Mechanisms

This is a market-based mechanism with an underlying regulatory obligation. Implementation mechanisms would need to focus on the incentive structure, research and development, technical assistance and education, and a potential pilot plant.

Related Policies/Programs in Place

Related program include rate reform/restructuring, energy efficiency resources, and environment as a criteria for decision-making, already before the NCUC in the Integrated Resource Planning proceeding. Rate programs already in place include energy conservation discount rate; time of use rates, real-time pricing, and curtailable rate options for customers.

Type(s) of GHG Reductions

Advanced fossil technologies are more efficient than conventional fossil technologies, and, therefore, have lower CO_2 emission rates. Advanced fossil technologies combined with carbon capture and sequestration or reuse (CCS) could enable significantly lower CO_2 emissions on the order of between 11% and 90%, depending on whether carbon capture/storage is considered.

Estimated GHG Savings and Costs per $MtCO_2e$

The table below summarizes the annual GHG reductions from this option in 2010 and 2020, the cumulative GHG reductions through 2020, the incremental cost of the option (expressed in net present value terms), and the cost-effectiveness of the option (expressed in terms of $ per tonne of CO_2e avoided). The results are presented relative to the replacement of a new 800-MW pulverized coal unit and the replacement of an existing 800 MW coal unit. Several sensitivity analyses were conducted and are also summarized in the table below.

Option Name	GHG Reductions (E6 tCO2e) 2010	2020	Total (2007–2020)	NPV of Costs (E6 2005$)	Cost of saved Carbon (2005$/$tCO_2$ e avoided)
IGCC with/without carbon capture & storage—replace new 800-MW plant					
With carbon capture & **storage** —central cost estimates	0.00	3.88	31.04	$949	$30.6
IGCC only	0.00	0.49	3.94	$46	$11.6
With carbon capture & storage—low cost estimates	0.00	3.68	29.46	$290	$9.8
With carbon capture & storage—high cost **estimates**	0.00	4.08	32.62	$1,664	$51.0
IGCC with/without carbon capture & storage—replace existing 800-MW plant					
With carbon capture & **storage** —central cost estimates	0.00	5.36	42.86	$2,061	$48.1
IGCC only	0.00	1.97	15.76	$1,158	$73.5
With carbon capture & storage—low cost estimates	0.00	5.16	41.28	$1,402	$34.0
With carbon capture & storage—high cost **estimates**	0.00	5.55	44.43	$2,777	$62.5

NPV = net present value

- **Data Sources:** EIA's Annual Energy Outlook (AEO) for 2006; IPCC report entitled "Carbon Capture and Storage," 2006.
- **Quantification Methods:** As noted in the table above, we have estimated the incremental cost of IGCC (with and without carbon capture and storage) relative to new and existing pulverized coal, and the difference in emissions using a simple spreadsheet analysis, which accounts for the additional energy needed for the capture and storage processes. We estimated the costs from the following perspectives:
  - IGCC only (no carbon capture/storage).
  - IGCC with carbon capture and transmission via pipeline, storage and monitoring costs, assuming sequestration in deep saline aquifers near North Carolina.

IGCC with carbon capture and transmission via truck to depleted natural gas fields in the Southwest.

- **Key Assumptions:** Costs of IGCC and pulverized coal plants are drawn from local sources, or from alternative sources such as AEO 2006, and assumptions for capture and storage are drawn from EPRI, MIT and IPCC.
- **Analytical issues:** There were several assumptions that were made in quantifying the GHG reduction benefits and cost-effectiveness of this option, as follows:
  - *IGCC targets:* It was assumed that 1,718 MW of coal capacity would be displaced.

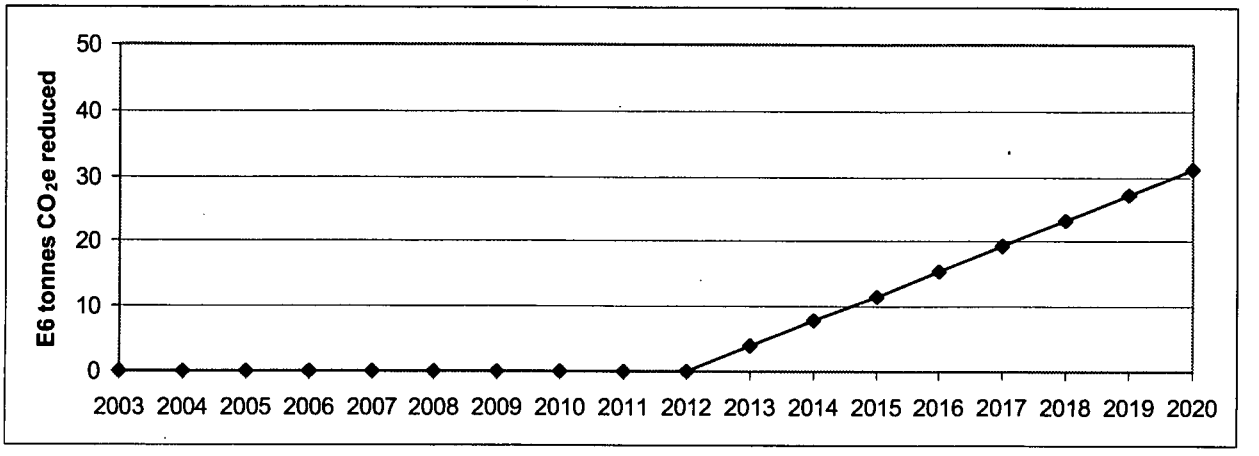
Levelized costs: Levelized cost assumptions in 2020 are provided in Table F-9. Sensitivities were considered regarding cost and performance characteristics of IGCC units with carbon capture and storage. The default assumption is the central value.

Table F-9. Levelized cost assumptions for the year 2020

Facility Type	Levelized Cost (2005$/MWh)
Pulverized coal	40.0
IGCC	53.4
IGCC with carbon capture & storage—low	43.5
IGCC with carbon capture & storage—high	102.1
IGCC with carbon capture & storage—central	71.7

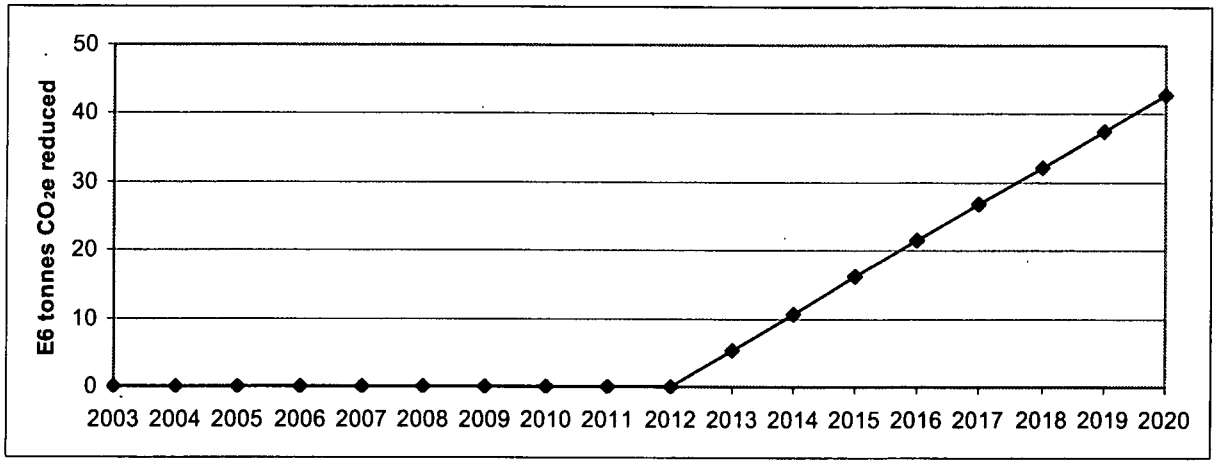
CO_2e emission factor and cumulative emissions for a new 800-MW coal station: An emission factor of 0.843 tCO_2e/MWh was used for new pulverized coal. An emission factor of 0.105 tCO_2e/MWh was used for IGCC with carbon capture and storage. Figure F-13 shows cumulative CO_2e emission reductions associated with the introduction of a large IGCC unit.

Figure F-13. Cumulative CO_2e emission reductions with large IGCC unit replacing a new 800 MW pulverized coal unit



CO_2e emission factor and cumulative emissions for an existing 800-MW coal station: An emission factor of 1.124 tCO_2e/MWh was used for pulverized coal. An emission factor of 0.405 tCO_2e/MWh was used for IGCC with carbon capture and storage. Figure F-14 shows cumulative CO_2e emission reductions associated with the introduction of a large IGCC unit.

Figure F-14. Cumulative CO_2e emission reductions with large IGCC unit replacing an existing 800 MW pulverized coal unit



Rate impacts: A number of sensitivities were conducted to explore rate impacts associated with this mitigation option. See the discussion under ES-1 for the method used to calculate rate impacts. A summary of rate impacts for each of the sensitivities is as presented in Table F-10.

Table F-10. Summary of rate impacts for each sensitivity.

Option #	Option Name	2000 Rate Impact (2005 c/kWh)		
		Energy Efficiency	Renewable Energy	Total
ES-6a	**IGCC with/without carbon capture & storage—replace new 800-MW plant**			
1	With carbon capture & **storage** —central cost estimates			0.0323
2	IGCC only			0.0016
3	With carbon capture & storage—low cost estimates			0.0098
4	With carbon capture & storage—high cost estimates			0.0566
ES-6b	**IGCC with/without carbon capture & storage—replace existing 800-MW plant**			
1	With carbon capture & **storage** —central cost estimates			0.0700
2	IGCC only			0.0393
3	With carbon capture & storage—low cost estimates			0.0476
4	With carbon capture & storage—high cost estimates			0.0943

Key Uncertainties

- North Carolina-specific costs of energy supply technologies modeled.
- Commercial availability of carbon capture technology.
- Viability of long-term storage of captured carbon

Additional Benefits and Costs

Lower level of disruption to coal supply industry.

Feasibility Issues

Integration of carbon capture with distribution to long-term storage site.

Status of Group Approval

Completed.

Level of Group Support

Unanimous consent.

Barriers to Consensus

None.

ES-7. Public Benefits Charge on Electric Bills to Support Energy Efficiency Programs

Mitigation Option Description

A public benefits charge (sometimes call systems benefits charge) is a fee that can not be bypassed that is added to a customer's bill for a given time period, based on use. The funds collected are then provided to a third party to provide energy efficiency programming. The purpose behind public benefits charges is most often to reduce energy consumption. While efficiency carries significant air quality and GHG benefits, that is rarely a consideration for creation of a program and is precisely the reason this option is considered.

Mitigation Option Design

North Carolina already has a public benefits charge. It is the oldest such program in the USA, established in 1980 by the NC Utilities Commission. The original intent was to reduce electric demand in order to slow the need for new power plants. The current public benefits charge is $0.003567/kWh and has not changed since its inception in 1980. It translates into approximately 3 cents/month per average residential customer in North Carolina, and raises approximately $3.5 million/year. For other states that have implemented a public benefits charge, the average charge is equivalent to $8.44 per customer and on average raises the equivalent of $72 million/year. In North Carolina, the public benefits charge should be increased to similar funding levels to provide for more efficiency initiatives (?).

Goals: Two goal levels are recommended, with the second goal dependent upon the first. The first goal is to gradually increase the public benefit charge to a funding level of $72 million/year, or equivalent to the national average. The second goal is to utilize that funding to meet about 1,000 MW/year in demand and 4,760 GWh/year in electricity consumption.

Timing: Program start-up in 2008. Linearly ramp up the increase to the public benefits charge over a 3-year period.

Coverage of Parties: Only investor-owned electric utilities are covered by the NC Utilities Commission. In the current public benefits charge, municipal utilities and electric cooperatives are invited to participate while only electric cooperatives actually participate in the program.

Other: Not applicable.

Implementation Mechanisms

The most effective implementation method would be to work through the NC Utilities Commission to increase funding in the established program. Not all funds would necessarily go to the same organization currently administering the fund.

Related Policies/Programs in Place

North Carolina has many fine organizations providing energy efficiency services that can be supplemented and improved with a n increase to the current funding levels.

Type(s) of GHG Reductions

A public benefits charges would displace coal-fired generation and the therefore lead to lower CO_2 emission rates in the State.

Estimated GHG Savings and Costs per $MtCO_2e$

The table below summarizes the annual GHG reductions in 2010 and 2020, the cumulative GHG reductions through 2020, the incremental cost of the option (expressed in net present value terms), and the cost-effectiveness of the option (expressed in terms of $ per ton of CO_2e avoided).

Option #	Option Name	GHG Reductions (E6 tCO2e)			NPV of Costs (E6 2005$)	Carbon (2005$/$tCO_2e$?] avoided)
		2010	2020	Total (2007–2020)		
ES-7	Public benefits charge	0.82	3.42	24.36	$329.0	$13.5

NPV = net present value

- **Data Sources:** EIA's Annual Energy Outlook (AEO) for 2006; RCI TWG inputs.
- **Quantification Methods:** This analysis of this option was carried out in collaboration with the RCI who will take the initial analytical steps.
- **Key Assumptions:** Cost and performance characteristics of individual energy efficiency and distributed renewable options as per assumption in the RCI TWG.
- **Analytical Issues:** There were several assumptions that were made in quantifying the GHG reduction benefits and cost-effectiveness of this option, as follows:

Targets: The targets for the PBF can be structured in various ways. Hence, the analysis was set up to consider the following sensitivities.

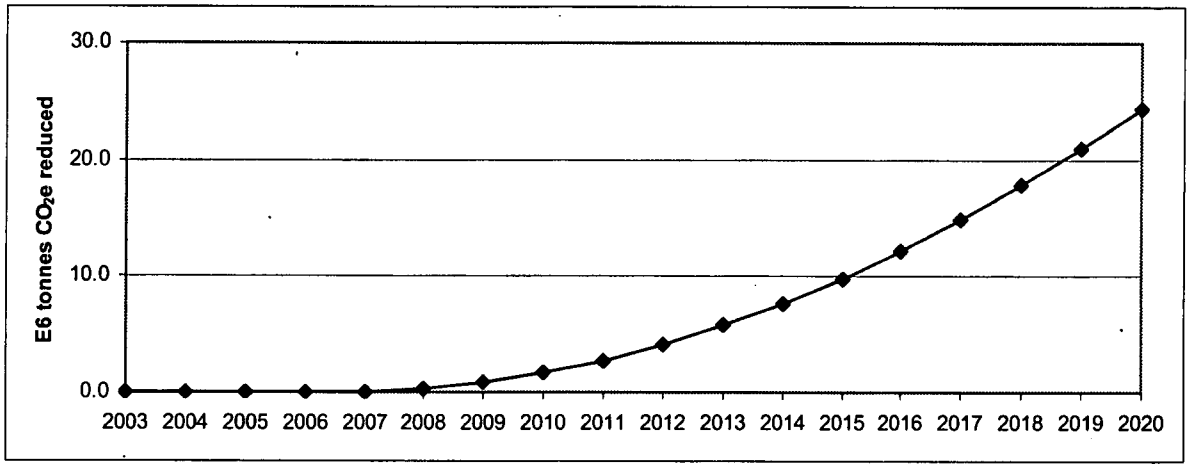
1. 4,760 GWh in reductions by 2020. This corresponds to a specific generation reduction target as advanced by the CAPAG for ES analysis. **Note that this is the default assumption and the results reflect this assumption.**
2. Default cost estimates for renewable energy technologies (based on EIA assumptions).
3. Low cost estimates for renewable energy technologies (based on the LaCapra study).
4. High cost estimates for renewable energy technologies (based on the LaCapra study).

- *Cost of efficiency measures:* A levelized costs of $46/MWh was assumed based on the results of the analysis conducted by the RCI TWG for option RCI-2.

- *Marginal impact of energy efficiency:* See the discussion under ES-1. The same default assumptions were used.

System CO_2e emission factor: See the discussion under ES-1. The same default assumptions were used to establish the average system emission factor. Figure F-15 shows the cumulative CO_2e emission reductions due to the PBF.

Figure F-15. Cumulative CO_2e emissions reductions due to PBF



Rate impacts: The rate impact associated with this mitigation option is 0.017 cents/kWh.

Key Uncertainties

- North Carolina–specific costs of energy efficiency investments at savings levels modeled.
- Future expected levels of spending vs. savings from public benefits charge program in North Carolina

Additional Benefits and Costs

- Co-benefits could include transmission/distribution system costs reduction.
- Would help to provide local employment and grow renewable energy use.

Feasibility Issues

- Costs dependant on particular measures included, and therefore uncertain.
- Interaction with RCI options such as appliance standards and utility programs needs to be taken into account.

Status of Group Approval

Completed.

Level of Group Support

Supermajority of Support (one objection).

Barriers to Consensus

None.

ES-8. Waste to Energy

Mitigation Option Description

The combustion of waste materials or its conversion by biological or thermo-chemical means can be used to produce heating, cooling or electric generation with lower GHG emissions than many conventional alternatives. The waste-to-energy mitigation option focuses exclusively on Municipal Sewage Treatment (MST) to produce electricity. This is due to the fact that landfill gas (LFG), animal waste, agriculture waste, and forestry waste are all covered under the Agriculture, Forestry, and Waste Management (AFW) TWG, and direct combustion of MSW is opposed by environmental interests.

Mitigation Option Design

The mitigation option would encourage the adoption of anaerobic digestion at MST facilities through direct subsidies to generate biogas for use in onsite engine-generators for electric power generation and heat to accelerate the treatment process. Even though the majority of generated energy will be used internally for plant operation, the municipally owned facilities should receive renewable energy credits, without having to sell the power at avoided cost and repurchasing it at retail cost.

Goals: 50% of North Carolina's new sewage treatment capacity would receive state directed funding to cover the incremental costs associated with installation and operation of on-site facilities for electrical and heat energy production from anaerobic digestion of waste sludge.

Timing: Program start-up in 2008.

Coverage of Parties: NC Utilities Commission, Utilities, NC Sustainable Energy Association, Department of Environmental & Natural Resources.

Other: Not applicable.

Implementation Mechanisms

This is a command/control mitigation option requiring a regulatory framework. The listed parties need to negotiate a satisfactory agreement, which fully values the GHG reduction benefits and the advantages to both the MST facilities and the environment for this bio-based distributed generation resource.

Related Policies/Programs in Place

There are no related policies or program currently in place in North Carolina to produce electricity or heat energy from municipal sewage treatment.

Type(s) of GHG Reductions

Without upgrading existing treatment facilities, capturing 50% of the new anticipated growth between now and 2020 would result in significant CO_2 reductions.

Estimated GHG Savings and Costs per $MtCO_2e$

The table below summarizes the annual GHG reductions in 2010 and 2020, the cumulative GHG reductions through 2020, the incremental cost of the option (expressed in net present value terms), and the cost-effectiveness of the option (expressed in terms of $ per ton of CO_2e avoided). The target of 50% of new public municipal wastewater technical energy capacity potential (MW) by 2020 was assumed. A total potential of 2.4 MW by 2020 was assumed.

Option #	Option Name	GHG Reductions (E6 tCO_2e)			NPV of Costs (E6 2005$)	Carbon (2005$/$tCO_2e$?] avoided)
		2010	2020	(2007–2020)		
ES-8	Waste-to-energy	0.0003	0.0034	0.02	($0.7)	($36.8)

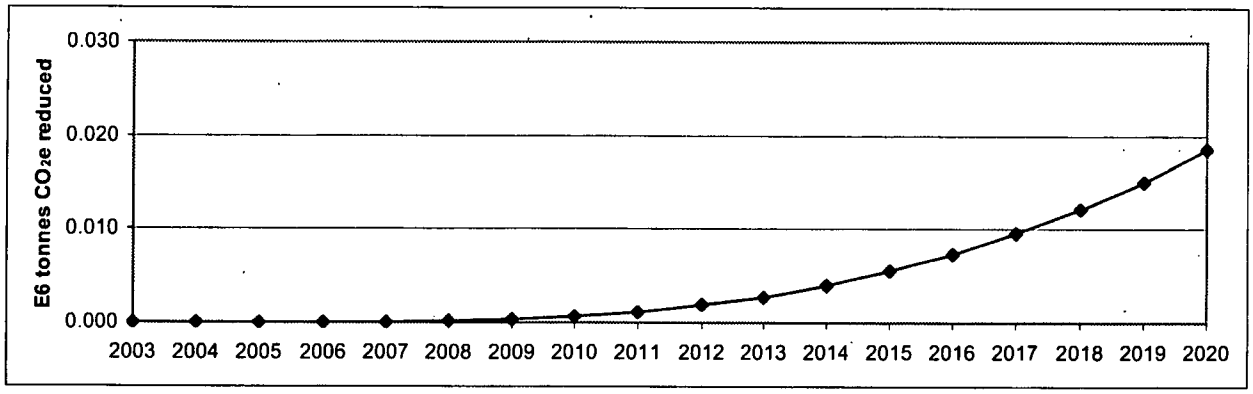
NPV = net present value

- **Data Sources:** EIA's Annual Energy Outlook (AEO) for 2006; Waste chapter of INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS AND SINKS: 1990-2004, USEPA #430-R-06-002, (April 2006); "Estimated use of water in the United States in 1990 Wastewater Treatment Water Use" by the USGS; "Clean Energy Technologies: A Preliminary Inventory of the Potential for Electricity Generation" by Owen Bailey and Ernst Worrell, LBNL-57451, April 2005.
- **Quantification Methods:** Incremental cost of waste to energy systems will be estimated relative to the most likely capacity they would displace on the system.
- **Key Assumptions:** TBD
- **Analytical Issues:** There were several assumptions that were made in quantifying the GHG reduction benefits and cost-effectiveness of this option, as follows:
  - *Technical Capacity:* Technical capacity associated with municipal waste was estimated at 12.8 MW based on the USGS[2] estimate of 546 wastewater treatment public facilities in North Carolina; a net public return flow of 562 million gallons/day (also from USGS); and an assumption of 22.7 MW per million gallons/day from Bailey and Worrel.[3]
  - *Targets:* A sensitivity analysis was set up to consider the following:
    1. Mid capacity target of 50% of the technical capacity by 2020. *Note that this is the default assumption and the results reflect this assumption.*
    2. Low capacity target of 20% of the technical capacity by 2020.
    3. High capacity target of 100% of the technical capacity by 2020.
    4. *Marginal impact of energy efficiency and renewable generation:* See the discussion under ES-1. The same default assumptions were used.
    5. *System CO_2e emission factor:* See the discussion under ES-1. The same default assumptions were used. Figure F-16 shows cumulative CO_2e emission reductions after the introduction of the waste-to-energy systems. The emission reductions

[2] Table 30 of "Estimated use of water in the United States in 1990 Wastewater Treatment Water Use" by the USGS.
[3] "Clean Energy Technologies: A Preliminary Inventory of the Potential for Electricity Generation," by Owen Bailey and Ernst Worrell, LBNL-57451, April 2005

account for the methane emissions that would otherwise be emitted to the atmosphere through anaerobic digestion.

Figure F-16. Cumulative CO_2e emission reductions with waste-to-energy systems



Rate impacts: The rate impact associated with this mitigation option is less than 0.0001 cents/kWh.

Key Uncertainties

- North Carolina–specific costs of technology modeled.

Additional Benefits and Costs

This option would also reduces emissions of local and regional air pollutants relative to coal-based production, such as sulfur and nitrogen oxides, which in turn reduce the human health and other impacts of those emissions.

Feasibility Issues

- Interconnection with electric system grid.

Status of Group Approval

Completed.

Level of Group Support

Unanimous consent.

Barriers to Consensus

None.

ES-10. NC GreenPower Renewable Resources Program

Mitigation Option Description

NC GreenPower is an independent, nonprofit organization established by the North Carolina Utilites Commision on January 28, 2003, to improve North Carolina's environment through voluntary contributions toward renewable energy. The goal of NC GreenPower is to supplement the state's existing power supply with more green energy—electricity generated from renewable resources like the sun, wind and organic matter. The program accepts financial contributions from North Carolina citizens and businesses to help offset the cost to produce green energy. NC GreenPower differs from a Renewable Portfolio Standard (RPS) in that the RPS requires that electric utilities provide a certain level of renewable energy capacity in their generation mix. NC GreenPower is entirely voluntary, with the revenue going toward paying incremental costs of renewable energy generation. Also, because all power purchased through NC GreenPower is produced inside the state, there are also economic development benefits.

Mitigation Option Design

This mitigation option aims to increase the effectiveness of the existing NC GreenPower program through a set of demand- and supply-side recommendations, as shown in Table F-11:

Table F-11. Demand- and supply-side recommendations

Demand-Side Recommendations	Supply-Side Recommendations
State facilities mandated to purchase a certain percentage of their power through NC GreenPower	Support for R&D on new and developing renewable energy technologies.
Provide incentives for new or expanding businesses to purchase NC GreenPower	Provide support for feasibility studies of various renewable energy technologies.
Provide tax credits for companies purchasing from NC GreenPower or who enable employees to do.	Provide a mechanism for long-term contract guarantees for renewable energy producers.
Provide incentives for home builders to include one year of green energy through NC GreenPower with the purchase of new homes.	Provide support for larger renewable energy development projects, thereby leading to more options and sales tools.
Provide assistance and participation in consumer and business marketing programs.	Ease ridge laws in the mountains to allow for wind energy development; work with the military for wind energy in coastal areas currently blocked
The should Work with the USEPA (through NCDENR) to ensure NC GreenPower is an option for air quality (AQ) violator restitution.	Provide low or no interest loans for qualified developers of renewable energy projects.
Ensure that AQ benefits of NC GreenPower are wedded to other benefits such as waste reduction, greenhouse gas emission reductions, and economic development	

Goals: All of North Carolina's state facilities would purchase at least 10% of their power from NC GreenPower.

Timing: Program start-up in 2008.

Coverage of Parties: NC Utilities Commission, Utilities, NC Sustainable Energy Association, Department of Environmental & Natural Resources.

Other: Not applicable.

Implementation Mechanisms

This is a command/control mitigation option requiring a regulatory framework. The listed parties need to negotiate a satisfactory agreement, which fully values the GHG reduction benefits and the advantages to both the MST facilities and the environment for this bio-based distributed generation resource.

Related Policies/Programs in Place

There are no related policies or program currently in place in North Carolina to produce electricity or heat energy from municipal sewage treatment.

Type(s) of GHG Reductions

Without upgrading existing treatment facilities, capturing 50% of the anticipated growth between now and 2020 would result in significant CO_2 reductions.

Estimated GHG Savings and Costs per $MtCO_2e$

The table below summarizes the annual GHG reductions in 2010 and 2020, the cumulative GHG reductions through 2020, the incremental cost of the option (expressed in net present value terms), and the cost-effectiveness of the option (expressed in terms of $ per ton of CO_2e avoided).

Option #	Option Name	GHG Reductions (E6 tCO2e			NPV of Costs (E6 2005$)	Carbon ($2005/tCO2e?] avoided)
		2010	2020	Total (2007–2020)		
ES-10	Strengthening the NC GreenPower program	0.01	0.16	0.95	$35.1	$37.0

NPV = net present value

- **Data Sources:** EIA's Annual Energy Outlook (AEO) for 2006; RCI TWG inputs.
- **Quantification Methods:** This analysis of this option will be carried out in collaboration with the RCI who will take the initial analytical steps.
- **Key Assumptions:** Cost and performance characteristics of individual energy efficiency and distributed renewable options as per assumption in the RCI TWG.
- **Analytical issues:** The following assumptions were made in quantifying the GHG reduction benefits and cost-effectiveness of this option:

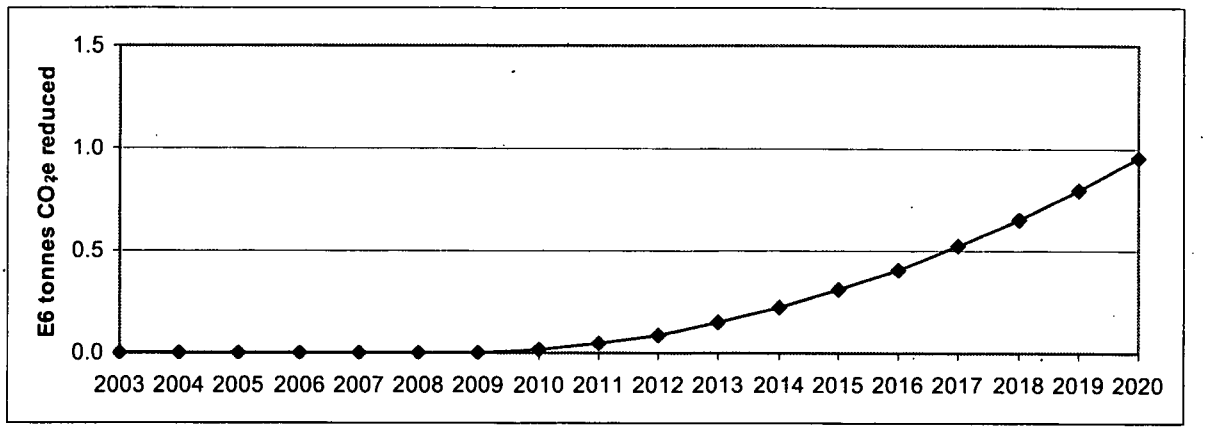
Targets: The targets were defined relative to the total generation needed to meet state demand for electricity (i.e., 2,890 GWh in 2020). It was assumed that the target is achieved entirely with renewable energy. The analysis was set up to consider two sensitivities, as follows:

1. RCI TWG analysis: This corresponds to a 10% target (relative to projected state demand for electricity) achieved by 2017 and remaining constant thereafter. *Note that this is the default assumption and the results reflect this assumption.*
2. This corresponds to 10% target (relative to projected state demand for electricity) achieved by 2020.

- *Marginal impact of energy efficiency:* See the discussion under ES-1. The same default assumptions were used.
- *Renewable energy mix:* See the discussion under ES-1. The same default assumptions were used.

System CO_2e emission factor: See the discussion under ES-1. The same default assumptions were used to establish the average system emission factor. Figure F-17 shows the cumulative CO_2e emission reductions due to the strengthened GreenPower program.

Figure F-17. Cumulative CO_2e emission reductions with strengthened GreenPower program



Rate impacts: The rate impacts associated with this mitigation option are summarized in Table F-12 for each sensitivity analysis.

Table F-12. Summary of rate impacts for each ES-10 sensitivity analysis

Option #	Option Name	2020 Rate Impact (2005 c/kWh)		
		Energy Efficiency	Renewable Energy	Total
ES-10	**Strengthening the NC GreenPower program**			
1	Original analysis (default assumptions)	0.0000	0.0012	0.0012
2	Original analysis–low levelized cost estimate	0.0000	0.0008	0.0008
3	Original analysis–high levelized cost estimate	0.0000	0.0015	0.0015
4	Original analysis–CCS levelized cost estimate (2% solar PV set-aside)	0.0000	0.0012	0.0012
5	Original analysis–low levelized cost estimate (2% solar PV set-aside)	0.0000	0.0009	0.0009
6	Original analysis–high levelized cost estimate (2% solar PV set-aside)	0.0000	0.0015	0.0015

Key Uncertainties

- North Carolina-specific costs of renewable energy investments at penetration levels modeled

Additional Benefits and Costs

- Would help to provide local employment and grow renewable energy use.

Feasibility Issues

- Interaction with other options to promote renewable energy needs to be taken into account.

Status of Group Approval

Completed.

Level of Group Support

Unanimous consent.

Barriers to Consensus

None.

Appendix G
Transportation and Land Use
Policy Options

	Mitigation Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2008–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of Support*
		2010	2020	Total 2008–2020			
TLU-1a	Land Development Planning	2.6	8.0	58.2	Net savings		SMJ
TLU-1b	Multi-Modal Transportation and Promotion (formerly TLU-2)	3.7	5.8	52.4	–1,300	–25	UC
TLU-3a	Surcharges to Raise Revenue	1.2	2.2	15.7	–1,800	–117	SMJ
TLU-3b	Rebates/ "Feebates" to Change Fleet Mix	0	< 0.5	2.8	Not quantified	–40 to +10	SMJ
TLU-4	Truckstop Electrification	Included in TLU-8			Net savings		UC
TLU-5	Tailpipe GHG Standards	0	8.1	44.5	–1,690	–38	SMJ
TLU-6	Biofuels Bundle	1.9	4.5	35.4	Not quantified		UC
TLU-7	Procure Efficient Fleets	Included in TLU-6					UC
TLU-8	Idle Reduction/Elimination Policies	0.1	0.2	2.2	–6	–4	UC
TLU-9	Diesel Retrofits	0.3	2.2	13.5	Not quantified		UC
TLU-11	Pay-As-You Drive Insurance	2.3	5.3	42.0	Expected net savings		SMJ
TLU-12	Advanced Technology Incentives	Not quantified					UC
TLU-13	Buses – Clean Fuels	Included in TLU-6					UC
	SECTOR TOTAL AFTER ADJUSTING FOR OVERLAPS	11.1	25.5	232.3	–4,350	–19	
	REDUCTIONS FROM RECENT ACTIONS	0	0	0	0	0	
	SECTOR TOTAL PLUS RECENT POLICY ACTIONS	11.1	25.5	232.3	–4,350	–19	

* UC = Unanimous Consent (all agree), SMJ = Super Majority (at least 80 percent or more agree). TLU-2 was renamed TLU-1b because if its linkage to TLU-1a. There is no policy option TLU-10, because this catalog option was determined not to be a priority for analysis by the CAPAG.

Note that for TLU-5, the estimated emission reduction for each year from 2008 through 2020 was multiplied by the cost-effectiveness value of -$38/ton to estimate cost savings for each year, and then the cost savings for each year was discounted and summed to estimate the NPV. Thus, the cost-effectiveness value of -$38/ton cannot be replicated by dividing the cumulative cost savings by the cumulative emission reduction shown in this table.

TLU-1a. Land Development Planning

Mitigation Option Description

Promote land planning and development that supports conservation of high quality natural and cultural resources and supports more compact development, and as a result reduces growth in driving and emissions.

Mitigation Option Design

Goals: Support and promote private and public planning and development practices, including infrastructure provision, that reduce the number, length, or travel mode of trips made in North Carolina.

Reduce projected increase in VMT by 10% statewide by 2020. (Value was developed after review of targets in several other states, and an assessment by the group of the ability to meet the target.)

Timing: Have policies in place to achieve that VMT goal by 2010.

Parties Involved:

- Private developers/contractors
- Local government planning/elected boards
- Planning staffs for towns and counties
- Homeowners

Implementation Mechanisms

Meeting the goal will require diverse implementation tools. Providing many options, statutory changes, and program assistance for smaller communities will be essential.

Land Use and Development Legislation to Require Adoption of a Growth Plan

- *Each municipality and county shall develop a land use and development plan.*

  The plan should designate planned growth areas and natural resource areas within that jurisdiction and any extraterritorial jurisdiction for a planning horizon of at least 25 years. The land use and development plan should include standards and criteria for conservation area and/or urban service area designations to accommodate a minimum 20-year growth forecast agreed upon by the each county and municipality; establish development and conservation goals; recognize important natural and human resources; and, express appropriate policies, practices and strategies to implement these goals. Local planning programs should include appropriate public involvement processes to achieve consensus on the development and conservation vision for the community.

- *Require and support integration of transportation with land use plans.*

  Maryland, Minnesota, and Denver, CO, as well as the non-profit Triangle Land Conservancy have developed "greenprints" of areas that have old-growth forests, productive agricultural lands, water supply watersheds, historic sites or other critical and irreplaceable resources. Adding this as a required element of all transportation plans would be a simple and meaningful step that would greatly enhance the effect and benefits of NC GS 136-66.2 without requiring new zoning or regulatory powers. The November, 2004 passage of tax increment financing legislation demonstrates that North Carolina can and does make room for new ideas that help achieve economic development goals in concert with infill development objectives. The N.C. Small Town Economic Development (NCSTEP) initiative created grant funds that are being used in 33 communities to plan for growth and development in a way that will help those communities benefit from growth and minimize negative impacts.

- *Regulatory incentives* such as withholding transportation funds for non-compliance have worked in Tennessee and should be considered in North Carolina as well.

Remove Barriers to Smart Growth

Many states have successfully implemented a variety of tools that are unavailable to North Carolina municipalities and counties due to prohibitions imposed by North Carolina statutes or constitution. Modify statutes to permit adequate public facilities ordinances, transfer of development rights programs, and development impact fees to improve the ability of local governments to control their own destinies.

Related Policies/Programs in Place

Development of a coordinated transportation system and provisions for streets and highways in and around municipalities.[1]

- The Department of Transportation may participate in the development and adoption of a transportation plan or updated transportation plan when all local governments within the area covered by the transportation plan have adopted land development plans within the previous five years.
- The Department of Transportation may participate in the development of a transportation plan if all the municipalities and counties within the area covered by the transportation plan are in the process of developing a land development plan.
- The Department of Transportation may not adopt or update a transportation plan until a local land development plan has been adopted. A qualifying land development plan may be a comprehensive plan, land use plan, master plan, strategic plan, or any type of plan or policy document that expresses a jurisdiction's goals and objectives for the development of land within that jurisdiction.
- At the request of the local jurisdiction, the Department may review and provide comments on the plan but shall not provide approval of the land development plan.

[1] See in § 136-66.2.

Coastal Area Management Act,[2] Cooperative State-local program.[3]
This Article establishes a cooperative program of coastal area management between local and State governments.

- Local government shall have the initiative for planning.
- State government shall establish areas of environmental concern.
- With regard to planning, state government shall act primarily in a supportive standard-setting and review capacity, except where local governments do not elect to exercise their initiative. Enforcement shall be a concurrent state-local responsibility.
- A wide variety of other state, regional, and local level planning and design programs, requirements, and efforts.

Types(s) of GHG Reductions

Mainly CO_2, small amounts of others.[4]

Estimated GHG Reductions and Costs (or Cost Savings)

- **GHG Reduction Potential in 2010, 2020 ($MMtCO_2e$):** 2.6, 8.0.
- **Cost-Effectiveness:** Expected net savings.
- **Data Sources:**

Vehicle Miles Traveled (VMT) impacts: A wide variety of literature finds that integrated transportation and land use planning can substantially reduce VMT[5] and its attendant emissions. The appropriate percentage reduction depends on the scale at which policies are applied.[6] Given the methodology used here, a 30% reduction in VMT at the level of an individual development / neighborhood is an appropriate value. This is conservatively below the reductions of 50% and higher that have been empirically observed in neighborhoods planned to allow multi-modal access and compact, mixed-use development.[7]

Costs: A wide variety of literature finds that integrated transportation and land use planning produces net savings on total costs of buildings + land + infrastructure + transportation. Some portions of that total cost of may be higher. Preponderance of literature suggests net savings

[2] See § 113A-100.

[3] See § 113A-101.

[4] The vast majority of the reductions from TLU options will be CO_2 from reduced fuel consumption. We note "and small amounts of others" given the reductions in other GHGs that would accompany the reduction in combustion, such as NO_2.

[5] US EPA, *Our Built and Natural Environments: A Technical Review of the Interactions Between Land Use, Transportation, and Environmental Quality*, 2001. http://www.epa.gov/dced/built.htm

[6] US EPA, *Guidance: Improving Air Quality Through Land Use Activities* (EPA 420-R-01-001, January 2001), and US EPA, *Comparing Methodologies to Assess Transportation and Air Quality Impacts of Brownfields and Infill Development* (EPA-231-R-01-001, August 2001).

[7] Cambridge Systematics, Inc., *Transportation Impacts of Smart Growth and Comprehensive Planning Initiatives: Final Report*, prepared for National Cooperative Highway Research Program, May 2004.

overall.[8] A National Academy of Sciences / Transportation Research Board review found substantial regional and state-level infrastructure cost savings from more compact development, as shown in Table G-1.[9]

Table G-1. Burchell findings of savings of compact growth versus current or trend development.

Area of Impact	Lexington, KY, and Delaware Estuary	Michigan	South Carolina	New Jersey
Public–Private Capital and Operating Costs				
Infrastructure roads (local)	14.8%–19.7%	12.4%	12%	26%
Utilities (water/sewer)	6.7%–8.2%	13.7%	13%	8%
Housing costs	2.5%–8.4%	6.8%	7%	6%
Cost-revenue impacts	6.9%	3.5%	5%	2%
Land/Natural Habitat Preservation				
Developable land	20.5%–24.2%	15.5%	15%	6%
Agricultural land	18%–29%	17.4%	18%	39%
Frail land	20%–27%	20.9%	22%	17%

We have not attempted to apply these kinds of cost reduction percentages to North Carolina's total infrastructure costs, but even at the low end of the above figures, the total savings would be in the billions.

- **Quantification Methods:**

Apply reductions to light-duty vehicles (LDVs) VMT only:

  - 15% of total VMT affected by these policies by 2012; 40% by 2020. So:
    - 2012 reduction = Statewide LDV * 15% * 30% = **4%** of total statewide heavy-duty vehicles (HDV) + LDV[10]
    - 2020 reduction = Statewide LDV * 40% * 30% = **10%** of total statewide HDV + LDV
  - Convert to CO_2

- **Key Assumptions:**

[8] Literature reviews include US EPA, *Our Built and Natural Environments: A Technical Review of the Interactions Between Land Use, Transportation, and Environmental Quality*, 2001; and Burchell et al. in footnote 8.

[9] Robert Burchell, et al., *The Costs of Sprawl—Revisited (TCRP Report 39)*, Transportation Research Board/National Research Council/National Academy Press, Washington, DC, 1998.

[10] We express the final result in terms of percentage reduction in LDV + HDV to provide for a common basis of comparison in terms of VMT. Since the ultimate output of interest is CO_2 / GHGs, it may be argued that this intermediate step is unnecessary, but many people find VMT percentage reductions a useful yardstick.

The given VMT and emissions reductions assume that the planning described in "Implementation Methods" will produce the changed growth patterns necessary to produce the stated goal.

Key Uncertainties

Achieving the given VMT goal depends on a vigorous implementation of the policy initiatives at all levels of government. It is possible that required planning could be done in a way that does not change development patterns, and thus does not reduce emissions. Thus the policy language does not *require* these outcomes.

Additional Benefits and Costs

Benefits from this policy option will increase over longer-term implementation.

Benefits include reduced infrastructure costs noted above, avoided health care costs from reduced air pollution and increased walking/biking, and other quality-of-life aspects.

Costs: There will be front-end costs of program development and implementation, and a successful program requires dedicated resources.

Feasibility Issues

None cited.

Status of Group Approval

Approved.

Level of Group Support

Supermajority.

Barriers to Consensus

Philosophical objection to planning.

TLU-1b. Multi-Modal Transportation and Promotion

Mitigation Option Description

Shift passenger transportation mode choice to lower emitting choices. Ensure that transportation is integrated with and appropriately serves land-use development plans (developed under TLU-1a). Implement the North Carolina transportation plan allocation of 13% of state transportation spending to transit.

Mitigation Option Design

Goals:

Implement policies that increase use of public transportation, producing a shift to lower emitting mode choices, by the following policies:

- Improve Transit Service (frequency, convenience, quality).
- Expand Transit Infrastructure (rail, bus, Bus Rapid Transit).
- Focus new development on transit-served corridors (Transit-Oriented Development).
- Expand Transit Marketing and Promotion (including tax-free and employer-paid Commuter Benefits, and Parking Cash Out).
- Expand Transportation System Management and Design, which speeds both transit and other traffic.
- Improve bike and pedestrian infrastructure both as feeders and as stand-alone modes.

Timing:

- Many programs are in place and are therefore immediately expandable/implementable. Enhancement and continuation can begin short-term.
- Infrastructure improvements will take 1-5 years at a minimum.

Parties Involved:

- NC DOT.
- Regional Transportation Districts.
- Metropolitan Planning Organizations.
- Regional Planning Organizations.
- Other regional authorities, such as RTP Rail Transit Authority.
- Municipalities.
- Counties.

Other: None cited.

Implementation Mechanisms

- Aggressively support and aid the creation of Regional Transportation Districts (RTDs). RTDs can sell bonds for capital projects, and member governments can levy taxes for operation and maintenance subject to voter approval.
- Make planning and funding rules more flexible to allow transit operators to provide service to places outside of their municipal jurisdictions.
- Abolish or reduce minimum parking requirements in zoning codes, and allow localities to establish parking maximums.
- Create a best practice guide and recognize developers who adhere to best practice when designing and locating new private and public development.
- Require planning to extend beyond 5 years (20 years recommended) for all systems.
- Create incentives or require the purchase of biodiesel fuel (minimum: B20) as a part of all public bus replacement programs. Conover has already done so with great results.
- Location of State Facilities—Locate state facilities near transit facilities. Where and when appropriate/possible all state government offices should be located downtown. Similarly, provide transit to serve concentrations of state employees.[11]
- State Targeting of Infrastructure Investments—Legislatively appropriated capital outlay funds, state public revolving loan fund, and other state-funded infrastructure initiatives should be used for projects that encourage walkable and traditional communities, and are supportive of transit.
- Make maintenance of infrastructure a priority—Fix it First. Revise any state infrastructure programs; transportation, water, sewer, that fund new systems but not maintenance or upgrades for existing systems.
- Replace "average cost pricing" for utilities services with rate structures that charge full marginal costs for both new infrastructure and for water, sewer, electricity, and telephone service delivery.
- Fund the transportation-related programs in this mitigation option with monies generated by other mitigation options such as feebates and/or gas tax.

Related Policies/Programs in Place

Overall, the North Carolina State Transportation Plan recommends spending 13% of total state transportation funding on transit over the next 25 years.

[11] This is an Executive Order from North Carolina Governor James Holshouser.

Statewide Transportation Demand Management Program (TDM)

- NCDOT-PTD supports the formation and ongoing activities of local TDM programs across the state by funding up to 50% of the cost of administering and marketing the services of the local TDM programs.
- Provide training for the TDM Coordinators operating the TDM programs. Currently, there are programs in the Charlotte, Asheville, Triad, Triangle and Wilmington areas of the state.
- In support of the TDM programs, the state funded, with local areas support, a ride-matching program that is available statewide which individuals can access through the internet to find or form carpools or vanpools for their daily commuter trips.
- The State is looking into adding a module to the program that allows individuals to enter trip needs that vary by day of the week, instead of the usual Monday through Friday work trip. The new module would allow part time workers, workers with variable work schedules and college students to find rides even though their trips are not regular throughout the week.

Intermodal Transportation Centers

- NCDOT-PTD works with municipalities in the states larger cities to develop intermodal transportation centers that allow for seamless movement between intercity passenger rail; intercity bus and city bus services. Currently, Greensboro has an intermodal center in operation which spurred double-digit increases in ridership on the city's bus system and the intercity bus operator after it opened. Rocky Mount has a successful intermodal center in operation. Additional projects are being developed in the following areas: Charlotte, Durham, Fayetteville, Greenville, Raleigh, Wilmington, and Winston-Salem.
- The state assists the municipalities in getting Federal Transit Administration funding, provides a 10% match to the 80% FTA funding and participates in the planning, land acquisition and design processes leading to construction of the centers.

Technology on Transit Vehicles and Facilities

- NCDOT-PTD supports the installation of new technologies on transit buses and in-transit facilities that make transit services more safe and efficient and that provide a higher level of information on the services for riders and potential riders. The state funds 90% of the cost of the technologies. Examples of such technologies include installation of cameras on buses (safety), real time transit service information signage at transit facilities (more information), compatible electronic fare boxes for systems in one region (ease of transit systems use) and installation of Automatic Vehicle Location (AVL)/Global Positioning Systems (GPS) systems on buses (more efficient operation and more information to passengers).

Types(s) of GHG Reductions

Mainly CO_2, small amounts of others.

Estimated GHG Savings and Costs per $MTCO_2e$

- **GHG reduction potential in 2010, 2020 ($MMtCO_2e$):** 3.7, 5.8.
- **Cost-Effectiveness:** Expected net savings.

- **Data Sources:**

Reductions from transit improvements: Transit economics literature.[12]

Reductions from TDM and transit promotion: TDM literature.[13]

Costs: Both the above, and transit cost/benefit analysis guidance.[14]

- **Quantification Methods:**

Emissions reductions

Apply reductions to urban LDV VMT only.

- Reductions from transit improvements:

2%	Current passenger miles traveled share for transit trips
25%	Percentage decrease in transit fares
80%	Percentage increase in service
0.4	Elasticity of transit demand with respect to price
0.8	Elasticity of transit demand with respect to service
2.20%	Calculate expected percent reduction in VMT (based on fare decrease)
3.28%	Calculate expected percent reduction in VMT (based on service increase)

  - 2012 reduction = **2.79%** of total statewide HDV + LDV
  - 2020 reduction = **2.76%** of total statewide HDV + LDV

- Reductions from TDM and transit promotion:

50%	Multiply urban LDV VMT by the percent of travel that can be reached by TDM
12%	Effectiveness of TDM measures for reducing VMT (through 2012)
20%	Effectiveness of TDM measures for reducing VMT (through 2020)
4%	Calculate expected percent reduction in commute VMT through 2012
6%	Calculate expected percent reduction in commute VMT through 2020

  - 2012 reduction = **3.05%** of total statewide HDV + LDV
  - 2020 reduction = **5.04%** of total statewide HDV + LDV

[12] See Brian E. McCollom and Richard Pratt. 2004. "Transit Pricing and Fares." TCRP Report 95. Washington, DC: Transportation Review Board; and Robert Cervero, 1990. "Transit Pricing Research." Transportation 17(2):117–140; and Victoria Transport Policy Institute, "Public Transit Improvements," in *TDM Encyclopedia*, 2005.

[13] Including ICF Consulting, "Strategies for Increasing the Effectiveness of Commuter Benefits Programs: Transit Cooperative Research Program Report 87," Transportation Research Board, Washington, DC, 2003; ICF Consulting, "Analyzing the Effectiveness of Commuter Benefits Programs: Transit Cooperative Research Program Report 107," Transportation Research Board, Washington, DC, 2005; and ICF Consulting, "Commuter Connections Strategic Review," report to the Maryland Department of Transportation Office of Planning and Capital Programming, November 7, 2004.

[14] "ECONorthwest, Estimating the Benefits and Costs of Public Transit Projects: A Guidebook for Practitioners," Transit Cooperative Research Program Report 78, Transportation Research Board/National Research Council/ National Academy Press, Washington, DC, 2002.

- Add reductions from multi-modal investments + reductions from TDM and transit promotion
- Convert to CO_2

Cost-effectiveness

The cost-effectiveness of investments in transit and transit promotion will vary depending on how those investments are made, and the Option language gives the state and its constituents wide flexibility in making those investments. A given investment in transit and/or transit promotion may or not produce net benefits, so while this process needs to make general policy recommendations, it will remain the responsibility of the state and its constituents to maximize the cost-effectiveness of investments made.

For the purposes of this analysis, we ask whether those types of investments are *likely* to produce net costs or net savings. A wide variety of empirical experience suggests that the policies and investments listed in the Option Design and Implementation Mechanisms sections are likely to produce substantial net savings, as in the following three examples.

1. *Transit investments generally*

Nationally, transit produces net economic returns on investment: "For every $10 million invested, over $15 million is saved in transportation costs to both highway and transit users. These costs include operating costs, fuel costs, and congestion costs." These are in addition to the ancillary benefits summarized below [see "Additional Benefits and Costs"].[15]

At a high level, then, the benefits of the proposed investment in transit can be estimated as follows:

NC DOT budget:	$2.5 billion/year
13%	$325,000,000/year
× 1.5 savings multiplier	$487,500,000/year in savings
–cost of investment	$325,000,000/year
Total benefits	**$162,500,000/year**

This substantial return on investment is the basis for the cost savings number reported in the summary table. Without knowing more about how North Carolina will make its transit investments, it is not possible to do a finer-grained analysis. However, the following examples suggest that the 1.5x savings multiplier may be conservative.

2. *Transit fare initiatives*

Unlimited Access transit at the University of California-Los Angeles costs $810,000 a year, and has total benefits of $3,250,000 a year,[16] a return on investment of more than 4x. Similar

[15] Cambridge Systematics, Inc., *Public Transportation and the Nation's Economy: A Quantitative Analysis of Public Transportation's Economic Impact*, 1999.1

[16] Jeffrey Brown, Daniel Hess, and Donald Shoup, "Fare-Free Public Transit at Universities: An Evaluation," *Journal of Planning Education and Research* (23:69–82), 2003.

programs at other universities show similar results.[17] The many educational institutions in North Carolina could see similar savings.

Universities are in some senses unique institutions, but the general types of challenges (especially demand for, and costs of providing, parking), and the types of benefits enjoyed in response to commute benefits programs, are equally available to businesses. A report on this topic notes:

> "Eco Passes also offer significant advantages for employers who offer free parking to all commuters, because those who shift from driving to transit will reduce the demand for employer-paid parking spaces. A survey of Silicon Valley commuters whose employers offer Eco Passes found that the solo-driver share fell from 76 percent before the passes were offered to 60 percent afterward. The transit mode share for commuting increased from 11 percent to 27 percent. These mode shifts reduced commuter parking demand by approximately 19 percent.
>
> "Given the high cost of constructing parking spaces in the Silicon Valley, each $1 per year spent to buy Eco Passes can save between $23 and $333 on the capital cost of required parking spaces."[18]

3. *Transit and non-SOV options information and promotion:* Per public dollar, a Transportation Management Organization (TMO) can accommodate seven times as many commuters as new highway investment.[19]

4. *TDM investments generally on the basis of avoided driving:* This policy is estimated to reduce VMT by 3,317,688,733 in 2012, and 3;970,779,011 in 2020. The current IRS-estimated cost of driving a mile in a personal vehicle is $0.485. At that rate, total savings will be

	2010	**2020** (constant $)
VMT reduced	$3,317,688,733	$3,970,779,011
@ $0.485 / VMT, Avoided costs =	$1.6 billion	$1.9 billion
–Cost of investment	$325,000,000	$325,000,000
Net savings	**$1.2 billion**	**$1.6 billion**

That is, the estimated $162,500,000/year in total savings used for the summary table is very conservative.

- **Key Assumptions:** Portions of TLU-1b support TLU-1a. The quantifications for TLU-1b focus on the role of transit, transit promotion and related initiatives. TLU-1a and -1b are labeled as (a) and (b) to emphasize their interdependent nature. We assume that they are implemented in concert to maximize effectiveness. Nonetheless, not all benefits are dependent on joint implementation. To use the Eco Pass example noted above, Silicon Valley has little land use planning of the type called for in TLU-1a, but Eco Passes still have substantial emissions reductions and other benefits. See "Feasibility Issues" for additional discussion.

[17] Jeffrey Brown, Daniel Hess & Donald Shoup, "Unlimited Access," *Transportation* 28:233–267, Kluwer, 2001.

[18] *Id.*, p. 260.

[19] Minnesota Department of Transportation, Modal Options Identify Project, "Measurement and Evaluation," 2006

Key Uncertainties

None cited.

Additional Benefits and Costs

There is a broad literature on the role of transit as a part of a modern economy and as a key contributor to creating and maintaining certain aspects of quality of life and a healthy, efficient economy. Overarching reviews of that literature are done only periodically; one of the most comprehensive being Cambridge Systematics (CS), Inc., *Public Transportation and the Nation's Economy: A Quantitative Analysis of Public Transportation's Economic Impact*, 1999. It lists the following additional types of benefits from transit investments. We give this list, and cite CS's bottom line estimate of transportation benefits above, not to suggest that North Carolina would necessarily see the same multipliers, but to support the above finding of a substantial savings multiplier from transit investments:

- "Transit capital investment is a significant source of job creation. This analysis indicates that in the year following the investment 314 jobs are created for each $10 million invested in transit capital funding.
- "Transit operations spending provides a direct infusion to the local economy. Over 570 jobs are created for each $10 million invested in the short run.
- "Businesses would realize a gain in sales three times the public sector investment in transit capital; a $10 million investment results in a $30 million gain in sales.
- "Businesses benefit as well from transit operations spending, with a $32 million increase in business sales for each $10 million in transit operations spending. [....]
- "Business output and personal income are positively impacted by transit investment, growing rapidly over time. These transportation user impacts create savings to business operations, and increase the overall efficiency of the economy, positively affecting business sales and household incomes. A sustained program of transit capital investment will generate an increase of $2 million in business output and $0.8 million in personal income for each $10 million in the short run (during year one). In the long term (during year 20), these benefits increase to $31 million and $18 million for business output and personal income respectively.
- "Transit capital and operating investment generates personal income and business profits that produce positive fiscal impacts. On average, a typical state/local government could realize a 4 to 16 percent gain in revenues due to the increases in income and employment generated by investments in transit.
- "Additional economic benefits which would improve the assessment of transit's economic impact are difficult to quantify and require a different analytical methodology from that employed in this report. They include "quality of life" benefits, changes in land use, social welfare benefits and reductions in the cost of other public sector functions.
- "The findings of this report compliment studies of local economic impacts, which carry a positive message that builds upon the body of evidence that shows transit is a sound public investment. Local studies have shown benefit/cost ratios as high as 9 to 1."

Feasibility Issues

Like any class of investment, the fact that empirically and on average the investment produces net returns does not guarantee that a given investment will do so. Transit investment and operation, and transit promotion, need to be tailored to the communities they serve, *and* be well planned, implemented, and run to produce the maximum return on investment (ROI). Emphasizing one aspect of TLU-1a or TLU-1b at the expense of another will reduce potential ROI and available emissions reductions.

Status of Group Approval

Approved.

Level of Group Support

Unanimous Consent.

Barriers to Consensus

None.

TLU-3a. Surcharges to Raise Revenue

Mitigation Option Description

Vary motor vehicle registration fees by vehicle emissions to provide a surcharge on higher emitting vehicles.

Mitigation Option Design

Goals:

- To raise funds for State of North Carolina to support transportation-related projects that reduce GHG.
- To raise funds through a mechanism that is directly tied to a significant source of GHG emissions from cars and trucks. It is not envisioned that the scale of the surcharge would affect the fleet mix; the goal of this policy is revenue-raising that is tied to emissions.

Timing: Should be implemented as soon as possible.

Parties Involved:

- Department of Motor Vehicles (DMV).
- Agencies that distribute and spend revenue.
- Consumers

Other: None Cited.

Implementation Mechanisms

Legislation-directed "surcharges."

- The Legislature would establish a surcharge schedule. One possible example follows:

  In light-duty vehicles, the appropriate emissions/efficiency factor is identified in Table G-2. This can be done by a DMV computer. This factor is based on the vehicle's Green Vehicle Guide rating, as published by EPA.[20] Incorporating the vehicle's Green Vehicle Guide rating, accounts for both fuel economy and emissions.

[20] See http//www.epa.gov/greenvehicles.

Table G-2. Emissions/efficiency factor for light-duty vehicles

Combined Score From EPA Green Vehicle Guide	Emissions/Efficiency Factor
19-20	10,000
17-18	9,000
15-16	8,000
13-14	7,000
11-12	6,000
9-10	5,000
7-8	4,000
5-6	3,000
3-4	2,000
<3	1,000

To calculate the surcharge, vehicle miles traveled (VMT) is divided by the emissions/efficiency factor, as shown in Table G-3.

Table G-3. Surcharge examples.

Vehicle	Vehicle Miles Traveled	Combined Score from EPA Green Vehicle Guide	Factor from Table G-2	Fee (VMT/Factor)
Toyota Prius	15,000	20	10,000	$1.50
Volkswagen Jetta Diesel, Manual	21,000	13	7,000	$3.00
Chevy Cavalier	49,000	14	7,000	$7.00
Toyota Land Cruiser	15,000	2	1,000	$15.00

- Generally, the surcharge design needs to be simple, minimize the number of pivot points, be well-documented, be designed to maximize not minimize consumer attention.
- During the past two legislative sessions, variations of a motor vehicle surcharge were introduced; these could be drawn on for more detailed policy language.

  Mobile Source Emission Reduction Program

  Establishes variable motor vehicle registration fees based on a vehicle's pollution and fuel economy score to generate funds for public and private sector use of alternative fuel and advanced transportation technologies. Funds would be distributed through the State Energy Office for transportation projects that support clean air renewable energy objectives. The committee proposed a substitute to set vehicle surcharges from $2–$14 annually.

  The above description implies an earmarking of funds so that they may only be used for activities that reduce GHG from travel; that provision may be made explicit.

  Design and implementation of this option should also take account of regional equity. Because urban areas generally offer economies of scope and scale in VMT reduction, it is possible that a disproportionate amount of funds could return to urban areas, although rural

drivers will pay the surcharges as well. Program design and grant criteria should take into account the policy goal of returning funds to contributing areas. There are numerous opportunities to reduce VMT and emissions in rural areas as well, from telework centers to appropriately designed transit.

Related Policies/Programs in Place

None.

Types(s) of GHG Reductions

CO_2.

Estimated GHG Reductions and Costs (or Cost Savings)

Emissions reductions

- 5.1 million North Carolina LDV registrations per year at an average of $7.25 per vehicle would produce $37 million per year for programs to reduce emissions from travel.
- The most efficient regionally funded regional commuter programs can reduce VMT for a cost of 2 cents/mile. Most regional commuter programs cost more per mile. On the other hand, few are as well funded as this proposal, and there are almost certainly economies of scale and scope.
- $37 million per year times $0.02 per mile equals 1,850,000,000 VMT = 2% of total statewide VMT; 3% of total urban LDV VMT.
- This achieves roughly half the amount of emission reductions produced by the "transit promotion and TDM" portion of TLU-1b: 1.0 $MMtCO_2e$ in 2010; 1.9 $MMtCO_2e$ in 2020.

This surcharge option is envisioned as likely to fund the types of transit promotion activities described in TLU-1b. As such, there are two quantification options:

- TLU-1b actions are envisioned to be funded out of the increased portions of the state transportation budget. If recommended increases are not available from the current transportation budget, this surcharge mechanism would be used. In this case, TLU-3a GHG reductions would not be reported separately.
- If TLU-1b options are funded at the level recommended in the state transportation plan, then the reductions achieved by implementing this surcharge option would be additive and reported separately.

For this analysis, we assume the second, additive option.

Costs/cost savings

If, as in the above example, revenue is used to fund multi-modal options promotion that reduces VMT, then we can estimate net benefits as show in Table G-4.

Table G-4. Estimated benefits: using surcharge revenues to fund multi-modal options.

	2010	2020 (constant $)
VMT reduced	$1,850,000,000	$1,850,000,000
@ $0.485 / VMT, Avoided costs =	$ 897,250,000	$ 897,250,000
–Cost of investment	$ 37,000,000	$ 37,000,000
Net savings	**$ 860,250,000**	**$ 860,250,000**

If, in an effort to be conservative, we limit the savings to the 7× savings multiplier found in a study for Minnesota DOT,[21] then the net benefits fall, as indicated in Table G-5.

Table G-5. Conservative estimate of benefits (used in Summary Table).

	2010	2020 (constant $)
Cost of investment	$37,000,000	$37,000,000
Avoided cost @ 7x investment	$259,000,000	$259,000,000
Net savings	**$222,000,000**	**$222,000,000**

We use this lower number in the summary table.

Data Sources: VMT reductions/$ from:

ICF, *Commuter Connections Strategic Review: Final Report*, For Maryland Department of Transportation, Office of Planning and Capital Programming, November 7, 2004.

Minnesota Department of Transportation, Modal Options Identify Project, "Measurement and Evaluation," 2006

Quantification Methods: Above.

Key Assumptions: $2–$14 surcharge has no direct effect on behavior. All reductions come from supporting other programs.

Key Uncertainties

Which programs would be funded with these monies. Program could be designed as an auction or bidding in order to fund the most cost-effective projects.

Additional Benefits and Costs

None cited.

Feasibility Issues

None cited.

[21] Minnesota Department of Transportation, Modal Options Identify Project, "Measurement and Evaluation," 2006

Status of Group Approval

Approved.

Level of Group Support

Supermajority.

Barriers to Consensus

Concern over effect on consumer choice.

TLU–3b. Rebates/ Feebates to Change Fleet Mix

Mitigation Option Description

Rebates/ feebates charge or rebate a sliding scale of fees and rebates for new light-duty vehicles based on their emissions of greenhouse gases, fuel consumption, and/or other measures of a vehicle's environmental impacts. This provides an incentive for manufacturers to sell cost-effective efficiency technologies, and for consumers to buy lower-emitting vehicles.

Mitigation Option Design

Goals: To reduce overall GHG emissions from new automobiles purchased in the state.

- By having price signals reflect emissions levels and thus have emissions level more directly enter buying decisions.
- By sending a signal to manufacturers to produce increasingly low-emitting vehicles for the market.
- By creating a dedicated revenue stream for promotion of low emitting or no emitting GHG transportation alternatives e.g., hybrid tax credits, transit infrastructure.

Timing: Should be implemented as soon as possible.

Parties Involved: All new light-duty vehicles registered in North Carolina.

- Consumers

Other: None cited.

Implementation Mechanisms

Legislation directed "rebates/ feebates."

- The simplest is to set the fee or the rebate in proportion to the amount of fuel consumed by the vehicle per mile driven. Specify the rate (in dollars per mile) and the "pivot point" between fees and rebates. The location of this pivot point will determine the net revenue flow.
- Emissions could be considered relative to other vehicles within each class or across classes based on their design variations.
- The rebate/ feebate could be set as a multiplier for an excise tax so that the fee or rebate is determined not only by the emissions rate of the vehicle but by its price as well.
- Generally the rebate/ feebate design needs to be simple, minimize the number of pivot points, be well-documented, and be designed to maximize consumer attention.

Related Policies/Programs in Place

Feebates have been proposed in many forms over the last fifteen years but have not yet been implemented in the United States. Rebate/ Feebate programs would work on two levels. First, the feebates would directly affect consumer choices for vehicle purchases as a result of the financial incentives. Second, the feebates could indirectly affect the types of vehicles and technologies that manufacturers offer. While feebate proposals have been described in academic studies, there has been no implementation of a full feebate program to date in the United States. While there is a "gas guzzler tax" and tax incentives for hybrid vehicle purchases, there is not yet any history of an on-the-ground example of an implemented feebate program.

Existing analysis shows that 90% of the benefits of feebate programs are likely to arise from the manufacturing response, as manufacturers change the technology mix in the fleet, rather than the consumer response, in which consumers change the mix of purchasing decisions within the current for-sale fleet. Also, manufacturers are unlikely to substantially change their technology mix in response to a single state feebate program. These studies have spurred an interest in multi-state feebate programs as a way to increase the increase the size of the affected market, and thus the incentive for manufacturers to shift technology mix. This policy option assumes only a North Carolina–level policy.

Types(s) of GHG Reductions

Mainly CO_2.

Estimated GHG Reductions and Costs (or Cost Savings)

- **Data Sources:**
  - CCS quantifications for feebates option for Arizona.
  - Marbek Resource Consultants in association with Resources for the Future and DesRosiers Automotive Consultants, *Development of Options For a Vehicle Feebate In Canada*, Final Report, October 13, 2005
- **Quantification Methods:**

Impacts: Attempts have been made recently to estimate the GHG emissions reduction potential from individual state feebate programs, including programs proposed for the states of Arizona and California. A rough extrapolation to North Carolina suggests that a stand-alone feebate program is unlikely to produce reductions of more than 0.5 $MMtCO_2e$ in 2020.

These recent estimates of the potential impacts of individual state programs are contingent upon assumptions and analytical methods that have not undergone thorough peer review. Therefore, the results of these analyses are preliminary and should be interpreted with caution. Further analysis and study of the potential benefits and costs of individual state and multi-state feebate programs would greatly increase confidence in projected results.

Costs: A wide variety of economics literature finds that vehicle buyers do not buy all the efficiency technology that is cost-effective, taking into account the net present value of both the fuel savings and the additional technology cost. Feebate analyses, the most recent of which is

cited above, find that the fuel savings that result from a feebate program would pay for additional costs, producing net cost savings:

> "The reduction in consumer surplus is more than compensated for by unvalued fuel savings that are realized. The benefits are positive for all rates up to $1000 but marginal costs begin to outweigh benefits between $500 and $1000. Adopting two or more classes reduces the benefits significantly while creating a relative subsidy for larger vehicles."
>
> As a result: Net benefits range from $40 per ton for a low feebate, to $10 per ton for a high feebate.
>
> "If it is assumed that consumers already fully value fuel savings, then there are no unvalued fuel savings and the costs are in the range of $10 per ton."

- **Key Assumptions:** That the North Carolina program is stand-alone.

Key Uncertainties

Until the United States has more experience with feebates, responses on both the consumer and producer sides are uncertain. In a single-state program, most of the response would come from the consumer side, as the production mix is unlikely to change substantially in response to demand changes a single state market.

Additional Benefits and Costs

None cited.

Feasibility Issues

None cited.

Status of Group Approval

Approved.

Level of Group Support

Supermajority.

Barriers to Consensus

Concern over effect on consumer choice.

TLU-4. Truckstop–and Places Where Trucks Stop–Electrification

Mitigation Option Description

Reduce idling-induced emissions from heavy-duty diesel trucks by providing electrical hook-ups to power heating, cooling, and other needs while stopped.

Mitigation Option Design

Goals:

- To reduce the engine emissions from diesel trucks (typically, tractor trailers) by allowing truck drivers to "plug in" engine heaters, HVAC, and other electrical devices
- To use Truckstop Electrification (TSE) to support Idle Reduction/Elimination (IR/E) policies.

Timing: Conduct analysis of existing pilot projects at major truck stops on Interstate highways (principally, I-40 and I-85) and initiate other efforts at other places where truck traffic is high. Then, progress to include all major truck stops statewide with at least one multi-unit electrified stop in each of the 17 urban areas in North Carolina.

Parties Involved:

- All long-haul truck drivers of tractor/semi-trailers.
- All combination trailers.

  USDOT requires all truck drivers to rest for at least 10 continuous hours after an 11-hour driving stint within every (24) hour day and 34 continuous hours once per week.

Other: Note that Truckstop Electrification may entail all off-board systems (often called shore power based on their use at marinas) or some on-board/some off-board systems. The all off-board option may be owned by the proprietor of the truck stop. On-board equipment is owned by the driver/owner or trucking company.

Implementation Mechanisms

Third-party vendors, truck stop owners, and trucking companies will play key roles in the advancement and absorption rate of this option. A state-shared responsibility for funding and promotion, coupled with a strong, phased-in Idle Reduction/Elimination policy, is one possible approach. Acquiring feedback during the initial projects (some of which are already in place in North Carolina) and modifying the program accordingly will be critical as well.

Related Policies/Programs in Place

North Carolina has several TSE pilots in place. While programs are in discussion there are no policies or laws to enforce participation. TSE is typically discussed during anti-idling legislation.

Pennsylvania, Oregon, and Washington[22] appear to have an existing program, as do certain cities, counties or other such, jurisdictions.

Types(s) of GHG Reductions

CO_2, carbon black.

Estimated GHG Reductions and Costs (or Cost Savings)

This mitigation option calls for a pilot program, but does not set penetration or adoption goals. As a result, we quantify cost-effectiveness, but assume that reductions are part of reductions achieved under TLU-8.

Data Sources:

Thomas L. Perrot, "Truck Stop Electrification As A Long-Haul Tractor Idling Alternative", ANTARES Group Inc., presented at the Transportation Research Board Annual Meeting, 2004.

Quantification Methods:

Perrot summarizes the results of a New York Interstate 90 Truck Stop Electrification (TSE) Demonstration study:

> "$1.70 (fuel) + $0.92 (maintenance) - $1.50 (Cost for TSE service) = $1.12 (Net savings per hour of use [to the trucker])"
>
> The key variable in that equation is the full cost of the TSE service. Perrot concludes:
>
> > "A TSE shore power facility installation can be engineered and installed at a cost that will provide a simple payback to the investor/owner in three years or less based solely on electrical supply. Revenue from other value-added services, such as cable TV, telephone and Internet service, will reduce the simple payback period."

Numerous other pilot studies are underway,[23] but based on the experience summarized here, we feel comfortable with a "net savings" forecast of costs.

Key Assumptions: See TLU-8.

Also, "Net savings" and "a 3-year payback" do not necessarily mean substantial market penetration without public-private partnership. For example, US EPA has a loan program for truckers to acquire fuel efficiency technologies; the technologies pay for themselves over time, plus reduce emissions, but due to a lack of market offerings, a public-private loan approach is being taken. Thus the mitigation option calls for additional pilots projects to test appropriate approaches for North Carolina.

[22] See http://www.treehugger.com/files/2005/10/truck_stop_elec.php.

[23] http://www.epa.gov/smartway/idle-demo.htm

Key Uncertainties

None cited.

Additional Benefits and Costs

None cited.

Feasibility Issues

None cited.

Status of Group Approval

Approved.

Level of Group Support

Unanimous consent.

Barriers to Consensus

None.

TLU-5. Tailpipe GHG Standards

Mitigation Option Description

Adopt the State Clean Car Program to reduce emissions of GHGs from vehicle operation.[24]

Mitigation Option Design

Goals: Use California Clean Car standards for cars and light trucks to reduce GHG emissions. California standards require GHG emissions reductions of about 30 % from new vehicles, phased in from 2009 to 2016, through a variety of means.[25] Other Clean Car Program elements include standards requiring reductions in smog- and soot-forming pollutants, and promoting introduction of very low-emitting technologies into new vehicles.

Timing: The General Assembly could enact legislation in 2009, earliest unless tied to a 2007 bill carried over to 2008 so that North Carolina can implement the California standards.[26]

Parties Involved:

- Automobile and light truck manufacturers.
- Car and light truck dealers.
- Consumers.

Implementation Mechanisms

Institute a regulatory program beginning with vehicle model year 2011.

Types(s) of GHG Benefit(s):

In this option, principally CO_2 reductions are felt with some reduction also in N_2O, CH_4, and refrigerant losses.[27]

Related Policies/Programs in place:

Federal regulation of tailpipe emissions.

Estimated GHG Savings and Costs Per Ton:

- **GHG Reduction Potential in 2010, 2020 ($MMtCO_2e$):** 0, 8.09.

[24] Also known as the "Pavley" standards (after Assemblywoman Fran Pavley who introduced the legislation) or "California GHG emission standards."
[25] For detailed information see: http://www.arb.ca.gov/cc/ccms/ccms.htm
[26] The California standards currently are being litigated, and timing may be affected as a result. Recent court decisions have found that CO2 can be a pollutant under the Clean Air Act (CAA). Many observers see this as clearing the way for the required EPA waiver under the CAA.
[27] See: http://www.arb.ca.gov/cc/factsheets/cc_isor.pdf. Note that the California standards apply not only to emissions from combustion, but also to other sources of GHGs in cars, such as refrigerants from air conditioning.

- **Cost-Effectiveness:** Net savings of $38 - $117/ton.
- **Data Sources:** CCS, Draft North Carolina Greenhouse Gas Inventory and Reference Case Projections, 2006.
- Mary Braun, Tony Dutzik, Jeanne Bassett, A Blueprint For Action: Policy Options to Reduce New Mexico's Contribution to Global Warming, New Mexico PIRG Education Fund, Spring 2006.
- Elizabeth Ridlington, Tony Dutzik, and Christopher Phelps, Cars and Global Warming: Policy Options to Reduce Connecticut's Global Warming Pollution from Cars and Light Trucks, Spring 2005.
- **Quantification Methods:**

Emissions reductions

CCS compared results from New England states, California, and a National PIRG model that were obtained using comparable modeling methods. CCS found that while all three modeling efforts were valid, reasonable, and comparable, some of the PIRG model assumptions and methods were relatively conservative, while the California and New England modeling results were relatively optimistic. CCS further refined the PIRG model results consistent with a middle range scenario that produced results less conservative than the PIRG results and less optimistic than the California and New England results. While PIRG projected a 13.7% reduction in light-duty vehicle emissions with this policy for Arizona, a CCS refinement estimated a 15.5% reduction in emissions for Arizona. CCS applied this same refined percentage reduction in emissions to the CAPAG reference case for North Carolina.

Costs

A review of past $/ton estimates prepared for the Pavley-type regulation for California Air Resources Board (CARB, Northeast States for Coordinated Air Use Management (NESCAUM), and CCS can produce an estimate of up to $117 saved for each metric ton of CO_2e reduced.

Other estimates predict lower net savings, or net costs. The California Air Resources Board (CARB) estimates that the cost of compliance in a new vehicle in model year 2016 would be approximately $1,000. To determine the net impact on consumers, CARB calculated the increase in monthly loan payments and the savings from reduced fuel consumption. CARB forecasts that consumers would achieve a net savings, starting at the time of purchase, of approximately $3.50 to $7.00 / month. Extrapolating this estimate of net savings to the North Carolina vehicle fleet would require an estimate of the NC Vehicle fleet in 2020, and NC does not make such a forecast. Total light duty vehicles in NC in 2006 were 5,097,000. If all of those turn over by 2020, and each saves $5/month, then net benefits would be:

(5,097,000 vehicles * $60/vehicle/year) / 8.1 tons = $37.80 $/ton savings.

In contrast, automobile manufacturers estimate that the California standards would cost around $3,000 per vehicle, and calculated that savings on fuel would offset less than half of that cost for consumers.

In an effort to be conservative, we selected a cost-effectiveness value of -$38. More than 10 other states have adopted the California standards; and among other factors that support the use of a savings estimate toward the higher end of the range, manufacturers should realize economies of scale that would lower manufacturing costs as additional states adopt the standards.

- **Key Assumptions:**
  - The three modeling efforts have established a valid and reasonable method of projecting GHG emissions reductions from this policy.
  - The CCS comparison of the three modeling methods provides some independent professional validation of the models and their results.
  - The key assumption of the emissions reduction projected by CCS is that the most likely scenario for emissions reductions is one that would fall between the more conservative scenario projected by the PIRG model and the more optimistic scenario projected by the California and the New England models.

Key Uncertainties

California's law is being litigated. North Carolina's ability to adopt California's standard depends on the US EPA issuing California a waiver under the Clean Air Act.

Once enacted, benefits depend on fleet turnover rates for light-duty vehicles and future patterns of consumer purchase choices between passenger cars and light-duty trucks e.g., SUVs.

Additional Benefits and Costs

Reductions in criteria air pollutants.

Feasibility Issues

None cited.

Status of Group Approval

Approved.

Level of Group Support

Supermajority.

Barriers to Consensus

Concern over potential costs.

TLU-6. Biofuels Bundle

Mitigation Option Description

This option seeks to increase market penetration of biofuels in North Carolina by a mixture of policies (voluntary and/or mandatory) to achieve feasible goals—offsetting fossil fuel use (gasoline) with production and use of starch-based and cellulosic ethanol.

Replacing gasoline with ethanol can reduce GHG's to the extent that the ethanol is produced with lower GHG content. Biodiesel has a lower GHG content than fossil diesel, so using biodiesel instead of fossil diesel reduces GHG emissions.

This option is linked with policy options AFW-2, Biodiesel Production, and AFW-6, Policies to Promote Ethanol Production. This option seeks to develop the demand for biofuels, whether produced locally or out-of-state. (Options AFW-2 and AFW-6 pursue the GHG benefits achievable beyond TLU options by promoting in-state production of ethanol and biodiesel using feedstocks and production methods with greater GHG benefits than the likely business-as-usual national market production methods, e.g., conventional starch-based ethanol.)

Mitigation Option Design

The goals for this policy should be phased in utilizing biofuels to replace the specified percentages of gasoline and diesel consumed for transportation throughout North Carolina by the specified years, as shown under Goal Levels, below. The goals of this policy can be achieved through a combination of a renewable fuels standards, financial incentives, outreach, and market-based mechanisms.

Goal Levels and Timing:

- The goal levels and timing for biofuels implementation are shown in Table G-6.
- The Governor and the Legislature would have the authority to change these targets (up or down) based on technical and/or economic feasibility.
- The Governor and Legislature could also set intermediate targets.

Table G-6. Goal levels and timing for biofuels implementation.

Phase	Year	Percentage of Gasoline to be Replaced by Biofuels	Percentage of Diesel to be Replaced by Biofuels
1	2010	10% (E10 equivalent)	5% (B5 equivalent)
2	2015	15% (E15 equivalent)	10% (B10 equivalent)
3	2020	20% (E20 equivalent)	15% (B15 equivalent)
4	2025	25% (E25 equivalent)	20% (B20 equivalent)

Parties Involved:

- State of North Carolina.
- Fuel retailers.
- Fuel wholesalers.
- Business owners.
- Car dealers.
- Biofuels producers.
- Alternative vehicle advocates.
- Private vehicle owners.

Implementation Mechanisms

Information and education:

Use information and education outreach to focus on voluntary methods of biofuels expansion. Provide the public with information on the use and effects of running their existing vehicles on ethanol. Target information and outreach about biodiesel use and effects to trucking and shipping companies, as well as smaller owner/operators in the State. Information should also be provided on where such vehicles can be purchased and on their environmental and fuel-saving benefits.

Technical assistance:

Provide technical assistance through vehicle dealers, consumer technical support groups and public demonstrations.

Funding mechanisms, market-based mechanisms, and incentives:

Pursue DOE and State funding for more alternative fuel pumps throughout the State and for introducing appropriate infrastructure throughout the State. Some federal tax incentives currently exist for the purchase of alternative fuel vehicles. When the federal incentives expire, examine the feasibility/need to continue such incentives for alternative fuel vehicles.

- Reduce or eliminate the motor fuels tax on biodiesel and ethanol (E85). Develop a system to provide for monthly credit for biodiesel and E85 blended fuel that would be equivalent to the state motor fuels tax owed on the biofuels portion of the fuel blend. (This could follow in the wake of elimination of tax on "home brew" biodiesel by 2007 legislature.)

  Monthly tax credits would be claimed on the same form (Biodiesel and Fuel Alcohol Providers Form) marketers currently file with the North Carolina Department of Revenue (DOR) Motor Fuel Tax Division to pay fuel tax. This would reduce pump price of Biofuels as marketers would pass most of the credit on to consumers to be competitive. Credits could be paid out of General State Revenues, DOT highway funds. Credit would be revenue neutral as it would be equal to the tax that would have been paid by marketers for biofuel portion of blend.

- Develop a $0.25/gallon credit for biodiesel and ethanol use in North Carolina vehicles.

As above, the tax credit would be claimed on the DOR Biodiesel and Fuel Alcohol Providers Form. Similarly, this would reduce price of Biofuels as marketers pass the credit on to consumer in order to be competitive. General state revenues, or DOT highway funds could pay for the credit. Unlike above, this credit would not be revenue neutral as the state would be providing incentive for fuel sold to non-taxable entities (local and state government) as well as sales to taxable entities. However, only the biofuel portion of blended fuel would be eligible for 25 cent credit. For example a B20 blend would get a 5 cent credit.

- Create a tax credit for biodiesel producers

Codes and standards:

This measure should include a mandated Renewable Fuel Standard (RFS), corresponding to the penetration rates listed above. The RFS should include a cost trigger, so that if the cost of alternative fuels exceeds conventional fuels by more than a specified amount, the RFS would be temporarily removed. The cost trigger should be based on costs over a period of time, and not spot prices. Additionally, production issues should be included in the trigger, such as water use in growing corn (or other crops) for the biofuels, such that the production of the biofuels does not increase GHG emissions or cause other resource problems.

Voluntary and or negotiated agreements:

- Provide financial incentives for alternative fuels distributors.
- Provide state funds and/or loan guarantees for construction of alternative fuels distribution facilities.
- Provide grow receipts tax exemptions, production tax credits and reduction in excise taxes on alt fuel sales.

Pilots and demos:

Show example of existing multi-fuel pumps in North Carolina which provides a model for dispensing three alternative fuels: B20 biodiesel, E85 ethanol and E10. The State's experience with these vehicles should be publicized.

Research and development:

- Pursue in-state biofuels production from a variety of sources.
- The State should push for significant federal funds for research and development needed to commercialize cellulosic ethanol technology and processes as this will be required for the ethanol targets for 2020 and beyond to be met.
- Analyze and quantify range of cost benefits that accrue to alt fuels vehicle owners.
- Research on production of renewable electricity and hydrogen will be required in order to implement a cost-effective process.

Related Policies/Programs in Place

The Energy Policy Act of 2005 includes provisions requiring an increasing volume of renewable fuel to be included in the gasoline sold in the United States starting in 2006 with 4 billion

gallons, increasing to 7.5 billion gallons by 2012. In this Act, renewable fuel includes motor vehicle fuel produced from grain, starch, vegetable, animal, or other biomass material, cellulosic biomass ethanol, waste derived ethanol, and biodiesel.

Types(s) of GHG Reductions

CO_2 emissions are reduced by offsetting the use of petroleum-derived gasoline and diesel. In order to assess the CO_2 benefit of using ethanol, the energy requirements of producing ethanol from starch needs to be compared to the energy requirements of producing gasoline. Current research indicates that starch-based ethanol production provides up to 18%–29% reduction in CO_2 from starch-based ethanol production compared to gasoline. To assess the benefits of using biodiesel, the overall energy required to produce biodiesel (e.g., life-cycle costs and benefits) must be compared to the energy requirements of producing fossil fuel diesel. Hill et al (2006) report that the energy available from biodiesel produced from soybeans is 93% greater than the fossil energy consumed in producing it.[28] Thus, biodiesel reduces lifecycle GHG emissions by as much as 41% compared with petroleum diesel.

Estimated GHG Savings and Costs per Ton CO_2e

Emissions reductions

The goals above would produce the following emissions reductions:

Note that some of these reductions would be attributable to the use of biofuels as a result of the national Renewable Fuel Standard (RFS) in the Energy Policy Act of 2005.

	Mitigation Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2008–2020 (Million $)	Cost-Effectiveness ($/t$CO_2e$)	Level of Support
		2010	2020	Total 2008–2020			
TLU-6	Biofuels bundle	1.9	4.5	35.4	Not quantified		Pending

Costs/cost-effectiveness

Two factors prevent us from making a defensible estimate of the costs associated with this option:

First, and most important, technology in alternative fuels production continues to be uncertain enough that a given cost estimate any distance in the future is likely unreliable. For example, the cellulosic ethanol technologies that form the basis of many projections are just now being tested to determine if they can be successfully commercialized.

Second, the rule-making for the nation RFS is not yet complete, and that will necessarily shape the economics of alternative fuels consumed in North Carolina.

[28] See Data Sources below.

- **Data Sources:**
  - *Environmental, Economic, and Energetic Costs and Benefits of Biodiesel and Ethanol Biofuels*, Jason Hill, et. al., University of Minnesota, published in Proceedings of the National Academy of Sciences of the United States of America, volume 103, no. 30, July 25, 2006.
  - *Well-to-Wheels Analysis of Advanced Fuel/Vehicle Systems – A North American Study of Energy Use, Greenhouse Gas Emissions, and Criteria Pollutant Emissions*, General Motors, Argonne National Lab, and Air Improvement Resource, Inc., May 2005.
  - "Documentation of Inputs to Macroeconomic Assessment of the Climate Action Team Report to the Governor and Legislature," California Climate Action Team, January 2006.
  - "State and Federal Standards for Mobile-Source Emissions," National Research Council of the National Academies, Washington, DC, 2006.
- **Quantification Methods:** Well-to-wheels CO_2 equivalent emission factors take into account the energy required to produce, process, and transport each fuel type (i.e., starting with the oil well for gasoline and the crop for starch-based ethanol). Such factors from a recent Argonne National Laboratory Study were used to estimate the benefits of offsetting conventional gasoline with starch-based ethanol in the amounts specified by the ethanol goals. Based on this source, the use of starch-based ethanol to replace gasoline is assumed to reduce CO_2e by 18.3%. The quantity of diesel fuel projected to be replaced in North Carolina with biodiesel was estimated based on the penetration rates of the above goals. A reduction in CO_2 emissions of 41% was applied to the quantity of diesel fuel replaced by biodiesel. (Hill et al, July 2006).
- **Key Assumptions:** This policy option assumes that the ethanol and biodiesel demand will be met with fuels available from a national market. Therefore, it is expected that the ethanol production would be starch-based and the emission factors used here reflect that.

Key Uncertainties

Some uncertainty remains regarding the ethanol production life-cycle emission factors as well as the availability of ethanol and biodiesel at the levels needed by this policy.

Contributing Issues

EPA has reported that the use of B20 biodiesel can lead to a 21% reduction in HC, 11% reduction in CO, and a 10% reduction in particulate matter (PM). Toxic emission reductions can also be significant. However, some forms/brands of biodiesel can lead to increased exhaust emissions of NO_x and some air toxics, depending on feedstock and blend level. EPA reports a 2% increase in NO_x emissions for B20 blends. In contrast, according to a recent analysis performed by the National Renewable Energy Laboratory, certain brands of biodiesel, such as Blue Sun Biodiesel B20, can reduce NO_x emissions by 4% to 5%. Effects on newer diesel vehicles are likely to be different. An increased penetration of biofuels reduces our foreign fossil fuel dependency.

Feasibility Issues

Members of the CCAG have expressed concern over the land and water resources needed to produce the amount of biofuels required by this policy option.

Status of Group Approval

Approved.

Level of Group Support

Unanimous consent.

Barriers to Consensus

None.

TLU-7. Procure Efficient Fleets

Mitigation Option Description

Reduce GHGs by increasing the efficiency of vehicle fleets generally, beginning with government lead by example. Also increase fleet use of alternative fuels.

Mitigation Option Design

Goals: Increase government fleet use of low-GHG fuels and more efficient vehicles to reduce greenhouse gas emissions from fleets. In addition to CO_2 reductions, reduce emissions affecting ozone, sulfur, and carbon monoxide loadings.

Timing: Statewide GHG reduction targets for fleets phased in over period of probably 8-10 years to allow fleet turnover to absorb most of the costs of replacing existing fleets. Other measures regarding more frequent maintenance and part specifications could be phased in much faster.

Parties Involved:

- All government fleet vehicle operators.
- Possibly private fleet operators.
- On-road passenger cars owners.
- Light-duty trucks owners.
- Bus fleet owners/operators.
- Heavy-duty trucks owners/operators.

Other:

Some places in North Carolina are already implementing green vehicle fleets in whole or part.

Implementation Mechanisms

Statewide policy specifying target adoption rates can come with an incentive or enforcement package.

Although hybrid cars and higher-fuel efficiency cars comprise the biggest part of the potential market for creating greener state vehicle fleets, better purchasing decisions on tires and maintenance schedules can also contribute significantly to higher fuel efficiencies and lower emissions.

Alternative fuel use credits can be implemented to assure the use of cleaner fuels and more efficient vehicles.

Credit can be accrued by the use of biodiesel, ethanol, CNG, propane, hydrogen, electricity and the by purchase of advanced technology vehicles such as hybrid electric vehicles. Such legislation was introduced but not passed during the 2005 session (SB1148). Text from the bill offered here as an example:

> *The State fleet shall accrue a total of 2,000,000 alternative fuel use credits during each calendar year 2006 and 2007. The State fleet shall accrue a total of 5,000,000 alternative fuel use credits during each calendar year 2008 and 2009. The State fleet shall accrue a total of 10,000,000 alternative fuel use credits during the calendar year 2010 and each calendar year thereafter.*
>
> (e) Formulas for Calculating Credits.—Alternative fuel use credits are calculated as follows:
>
> (1) Subject to subdivision (2) of this subsection, one alternative fuel credit accrues for each one gallon of one hundred percent (100%) alternative fuel utilized by a State fleet vehicle. When alternative fuel is blended with petroleum-based fuel, the alternative fuel credit accrues for each one gallon of alternative fuel utilized by a State vehicle at a rate that is based on the percentage of alternative fuel that is utilized by a State fleet vehicle. (For example, one alternative fuel use credit accrues for every five gallons of B20 that is utilized by a State fleet vehicle.)

Thus, in 2012, the goal of that language is to move 10,000,000 gallons of fuel from fossil to bio.

Related Policies/Programs in Place

Many cities, including Raleigh, Durham, Greensboro, Hickory, Conover, Charlotte and others have converted part or all of their fleets to cleaner-burning fuels such as B20, compressed natural gas (CNG), ethanol, and electric hybrids. North Carolina has vigorously acquired flexible fuel vehicles (FFVs) and uses E85, E10, and biodiesel on more than 3,000 vehicles.[29]

Budget provision 19.5 of the 2005 North Carolina budget required the displacement of 20% petroleum from state fleet vehicles by 2010. These mandated goals (affecting state fleets greater than 10 vehicles) have expanded use of Biodiesel (B20) and ethanol (E85). For example NC DOT has already announced expansion of B20 refueling to over 100 state refueling facilities in North Carolina.

Types(s) of GHG Reductions

Mainly CO_2.

Estimated GHG Reductions and Costs (or Cost Savings)

Because most of the GHG reductions and costs for this option come from alternative fuel use, they are incorporated into costs and benefits reported under TLU-6, Biofuels Bundle.

[29] See http://www.eere.energy.gov/afdc/pdfs/37133.pdf#search=%22green%20vehicle%20fleet%2C%20NC%22

- **Data Sources:** Please see TLU-6
- **Quantification Methods:** Please see TLU-6
- **Key Assumptions:** Please see TLU-6

State procurement of efficient fleets will continue to help the state lead by example, and spur the alternative fuels market (both provision and infrastructure). CCS analysis suggests that this option will not add meaningful additional CO_2 emissions reductions to the reductions that would be gained through TLU-6 and through existing actions. Nonetheless, a public relations effort would beneficially publicize the achievements thus far, and how other fleets could benefit as well?

Key Uncertainties

None cited.

Additional Benefits and Costs

None cited.

Feasibility Issues

None cited.

Status of Group Approval

Approved.

Level of Group Support

Unanimous consent.

Barriers to Consensus

None

TLU-8. Idle Reduction / Elimination Policies

Mitigation Option Description

Implement state and local policies to reduce hours of operation and thus emissions from idling trucks and buses (principally), perhaps off-road engines as well.

Mitigation Option Design

Goals:

- To reduce greenhouse gas emissions from heavy vehicles.
- Reinforce Truckstop Electrification (TSE) support.

Timing: Phased in; at full strength within five years of initiation.

Parties involved:

- All heavy truck owner/operators.
- Public bus fleets owner/operators.
- Private bus fleets owner/operators.

Other: Exemptions for emergency vehicles, maintenance tasks, and similar cases. Note that "idling" here does not cover idling while stopped in traffic.

Implementation Mechanisms

This would require working with trucking groups, truck stops, and places where trucks stop as well as with government to formulate an agreeable policy approach, phasing schedule, and legislative content.

Related Policies/Programs in Place

About 15 states and a number of local governments have adopted anti- idling legislation.[30] More are sure to follow or are already being discussed at some level. Toronto has had a law in place since 1996. Many North Carolina counties and the State Board of Education (Policy No. EEO-M-003) have adopted school bus idling policies already.[31] The Clean School Bus USA program (USEPA) should also be consulted.[32]

Types(s) of GHG Reductions

Mainly CO_2, some black carbon.

[30] See http://atri-online.org/research/idling/Cab%20Card%20July%202006.pdf
[31] See http://www.ncbussafety.org/idling.html
[32] See http://www.epa.gov/cleanschoolbus/

Estimated GHG Reductions and Costs (or Cost Savings)

- **Anti-Idling GHG reduction potential in 2010, 2020 ($MMtCO_2e$):** 0.1, 0.2.
- **Anti-Idling Cost-Effectiveness:** –$4/ton.
- **Data Sources:**

Reductions

Idle-reduction technologies and policies could reduce per-vehicle fuel use by 3% to 9% annually:

J. Ang-Olson and W. Schroeer, "Energy Efficiency Strategies for Freight Trucking: Potential Impact on Fuel Use and Greenhouse Gas Emissions," *Transportation Research Record.*

Reductions and costs

American Transportation Research Institute, "Idle Reduction Technology: Fleet Preferences Survey," February 2006 for technology costs.

EPA SmartWay Transportation Partnership (www.epa.gov/otaq/smartway/idlingtechnologies.htm#truck-mobile) for technology costs.

"Analysis of Technology Options to Reduce the Fuel Consumption of Idling Trucks," ANL/ESD-43, Argonne National Laboratory, Transportation Technology R&D Center, June 2000 for information on technology impacts.

- **Quantification Methods / Key Assumptions:**

Impacts

Impacts assume the penetration rates shown in Table G-7.

Table G-7. Assumed penetration rates and resulting impacts

10%	Percent of heavy duty travel (by VMT) by public sector.
50%	Percent of public sector heavy-duty VMT observing anti-idling through 2012.
40%	Percent of private sector heavy-duty VMT observing anti-idling through 2012.
80%	Percent of public sector heavy-duty VMT observing anti-idling through 2020.
70%	Percent of private sector heavy-duty VMT observing anti-idling through 2020.
95%	VMT-equivalency conversion factor of idling to non-idling vehicles in 2012.
95%	VMT-equivalency conversion factor of idling to non-idling vehicles in 2020.
2.05%	Calculate expected percent reduction in VMT-equivalency of conventional vehicles for 2010.

3.55%	Calculate expected percent reduction in VMT-equivalency of conventional vehicles for 2040.

Costs

The cost analysis assumes a 5-year lifetime for idling technology equipment, applied to 80% of Class 8 vehicles starting in 2008 and 100% of Class 8 vehicles starting in 2015, at a cost of $6,000 per vehicle and a $2.40 per gallon diesel cost savings.

Program administration costs, enforcement costs, fines, and reduced vehicle maintenance costs have not been factored into the cost analysis.

Key Uncertainties

The use of truck stop electrification would increase emissions from electricity generation. Equipment cost and lifetime will vary by technology employed. The cost value selected was based on cost data summarized by American Transportation Research Institute, representing the capital costs of a variety of idle reduction technologies. The cost of $6,000 per vehicle represents a mix of higher and lower technology costs. The cost analysis does not take into account the number of vehicles that have already installed idle reduction technologies. The fuel cost assumed here is based on long-term projected fuel costs. Increases in this assumed fuel cost will lead to greater cost savings for this measure.

Additional Benefits and Costs

None cited.

Feasibility Issues

None cited.

Status of Group Approval

Approved.

Level of Group Support

Unanimous Consent.

Barriers to Consensus

None.

TLU-9. Diesel Retrofits / Retirement

Mitigation Option Description

Reduce diesel emissions from older diesel engine/emission systems through retrofit and/or retirement. Create incentives and encourage retrofits through a combination of funding and education/promotion.

Mitigation Option Design

Goals:

- Reduce children's exposure to diesel emissions by retrofitting school buses in North Carolina with diesel oxidation catalyst (DOC) control devices, and/or diesel particulate filters, which have the auxiliary benefit of reducing some GHGs and carbon black.
- Speed retirement and/or retrofit of all older diesels through information and incentives.

Parties involved:

- North Carolina school buses owners/operators.
- All North Carolina diesel truck owners/operators.

Other: None cited.

Implementation Mechanisms

- **Utilize various funding mechanisms** to purchase DOC pollution control devices and/or particulate traps for school buses that are not equipped with pollution control devices.
- **Information and education:** An information and education component is needed to provide truck and bus owners, school districts, and municipal organizations with information regarding the significant emission reductions that could be achieved by retrofitting or retiring certain truck or bus engines with high annual emissions and replacing them with vehicles meeting the new emission standards. Provide information on potential funding partners, grants, or loans available from a number of organizations for this purpose.
- **Funding mechanisms or incentives:** Develop a loan or grant program allow truck owners to accelerate new vehicle purchases or to apply retrofit technologies to their fleets.

Related Policies/Programs in Place

Currently in North Carolina, there is an ongoing effort to retrofit school buses across the State with diesel pollution control devices. An estimated 15% of the school buses in the State are already equipped with some type of pollution control device. Sources of funding include Federal and State grants, local funding and gifts from private industry. The primary purpose of these diesel pollution control devices is to reduce particulate matter.

Legislation currently under consideration, HB 1912: School Bus Retrofits in Nonattainment Areas, addresses school bus retrofits.

The legislation establishes a pilot program, to be administered by North Carolina DENR, to provide grants to retrofit school buses in the nonattainment and maintenance areas across North Carolina. The bill does not specify the use of any particular control technology.

Types(s) of GHG Reductions

DOCs and particulate filters remove varying amounts of pollutants depending on design and manufacturer. EPA has verified a range of substantial (20% to 90%) reductions in PM, CO, NO_x, HC,[33] and PM contains carbon black.

Estimated GHG Reductions and Costs (or Cost Savings)

Emissions impacts

Multiple fuel economy studies have reported that either DOCs have no impact on fuel economy or have a slight decrease that is not statistically significant.

This mitigation option sets no adoption or penetration goals, and GHG reductions are secondary. Further, given the variability in NO_x reductions, it is impossible to estimate GHG reductions without knowing the types of DOCs likely to be used. As a result, GHG reductions are not quantified.

Costs

In 2000, CARB estimated the expected cost of DOC technology by horsepower rating as shown in Table G-8.

Table G-8. CARB-estimated costs of DOC technology.

Engine Horsepower	Hardware Cost
40	$400–$600
100	$680–$1,356
275	$2,100–$3,700
400	$2,800–$3,700
1,400	$10,000–$20,000

Recent estimates suggest the costs for DOCs in retrofit applications are decreasing slightly and range from under $500 up to $1,250 for engines in the 100–200 horsepower category, and from less than $1,000 up to $1,750 for engines in the 200–500 horsepower category. DOC installation typically takes one to two hours. If installation service is provided by the technology suppliers or agents, the cost is in the range of less than $100 to about $200. Since, DOC installation is relatively straightforward, fleet mechanics will sometimes install the DOCs themselves after receiving training from the DOC supplier. This cuts installation costs after receiving training from the DOC supplier. Since DOCs are virtually maintenance free—requiring only periodic

[33] http://www.epa.gov/otaq/retrofit/retroverifiedlist.htm

checks of the catalyst and exhaust system for mechanical integrity—no additional maintenance costs are incurred.[34]

Because this option leaves open the choice of technology, and within technologies there is a wide range of costs and of effectiveness, it is not possible to provide a cost-effectiveness estimate for this option. However, as a way to suggest potential cost-effectiveness values, we excerpt here from two recent studies study of policy options to reduce diesel emissions, one from North Carolina, and one national.

Southern Alliance for Clean Energy and Carolinas Clean Air Coalition, "A Case for the Healthy School Bus: Lessons from the Field. Results of a Cabin Air Quality Demonstration Project on Diesel School Buses in Charlotte, North Carolina," December 2006[35]

This report is quite thorough, and though it does not give cost-effectiveness figures, it provides in-depth, North Carolina testing-based discussion of the merits of different school bus retrofit technologies.

> "Advanced pollution control technologies, cleaner fuels and model management practices are currently being implemented throughout the state considerably reducing diesel soot, but more is needed. Only 15 cities or counties in North Carolina have taken action to reduce emissions from their local school bus fleets. Of the approximately 13,600 yellow school buses in the state, only 1,159 (12%) school buses are retrofitted or will be retrofitted soon with pollution control devices."
>
> "The retrofit combination of a diesel particulate filter and a closed crankcase ventilation system demonstrate virtual elimination of all diesel soot inside the school bus cabin."
>
> "Concentrations of black carbon were elevated on all buses except the bus retrofit with a DPF and CCV. Black carbon is a significant contributor to global warming and is the main component of diesel soot, making up 94 percent of a diesel soot particle.
>
> "Diesel soot gathers on snowy surfaces, attracting more sunlight, which in turn melts more snow and ice. According to NASA studies, this soot is twice as potent as carbon dioxide in changing global surface temperature in the Northern Hemisphere and the Arctic."
>
> "The retrofit combination of a diesel particulate filter with the closed crankcase ventilation system (Spiracle used in this test) demonstrated elimination of all diesel soot particles (PM2.5, ultrafine particles and black carbon) [*CCS note: inside the school bus cabin*] in the Charlotte demonstration and in all other cities where tests were conducted. The consistent evidence and effectiveness of these technologies in all cities confirms results found in the Charlotte demonstration. We recommend this retrofit combination, a DPF and a closed crankcase ventilation system, as the best solution for reducing diesel soot inside school buses. These devices should be installed on all applicable school buses in North Carolina."

Environmental Defense, "Cleaner Air for America: The Case for a National Program to Cut Pollution from Today's Diesel Engines," 2005.[36]

This report estimates that public investment in a technology-focused diesel control program could pay substantial health and health cost dividends. The report evaluates a broader proposed program than the one proposed in this option, but the figures may help give a sense of what at least one group believes the returns may be

[34] Western Regional Air Partnership, Offroad Diesel Retrofit Guidance Document, Volume 2, Section II.
[35] http://www.cleanenergy.org/resources/reports/NC%20Diesel%20Report%20final.pdf
[36] http://www.environmentaldefense.org/documents/4488_cleanerairamerica.pdf

> "Investments in a national diesel control program yield healthy returns. An investment in diesel engine retrofits ranging from $600 million to $1.6 billion yields a multi-year stream of health benefits with a net present value ranging from $10.6 to $19.2 billion."
>
> "Using EPA's valuation methodologies, we found that investment in a national diesel pollution control program will yield healthy returns. Figure 1 shows the lump sum costs of applying the two technology scenarios to school buses, transit buses and construction equipment in the 50 most populated cities ranged from $600 million to $1.6 billion. The net present value of the resulting health benefits far exceeded these costs, and ranged from $10.6 billion to $19.2 billion."
>
> "Our two scenarios assumed installation of DPFs and DOCs within the studied counties. Because these two technologies vary significantly in applicability and pollutant removal efficiencies, these two scenarios illustrate the range of costs to achieve steep reductions from a limited set of engines and more modest reductions over many more engines. The scenarios are illustrative. The appropriate mix of pollution reduction strategies will vary widely across communities."

- **Quantification Methods:** Not applicable.
- **Key Assumptions:** None cited.

Key Uncertainties

None cited.

Additional Benefits and Costs

The primary benefits produced would be in health, especially children's health.

Feasibility Issues

None cited.

Status of Group Approval

Approved.

Level of Group Support

Unanimous consent.

Barriers to Consensus

None.

TLU-11. Pay-As-You-Drive Insurance

Mitigation Option Description

Pay-As-You-Drive (PAYD) pricing converts a portion of insurance to a variable cost with respect to vehicle travel, so premiums are directly related to mileage. PAYD makes insurance more actuarially accurate and allows motorists to save money when they reduce their mileage. The less you drive the more you save.

Mitigation Option Design

Goals: To reduce GHG emissions from automobiles by influencing individual drivers to reduce their annual VMT.

Timing: Proposal would require insurance companies to offer PAYD as part of their menu of insurance choices in North Carolina. A pilot project could be implemented first on a small scale as soon as possible. Option design is to have full North Carolina light-duty fleet PAYD coverage by 2020.

Parties Involved:

- Insurance companies.
- All motorists insured in North Carolina.

Implementation Mechanisms

Require insurance companies to offer PAYD as part of their menu of insurance choices in North Carolina.

Implementation technologies to be determined through rule-making, taking into account available and other required technology.

- Insurance companies could bill motorists based on their monthly vehicle mileage similar to other utilities or annually.
- Variations in the policy design can address geographic and/or equity concerns.

Related Policies/Programs in Place

GMAC and On-Star Offers Low-Mileage Discount Rates[37]

Since mid-2004 the General Motors Acceptance Corporation (GMAC) Insurance has offered mileage-based discounts to OnStar subscribers located in certain states. The system automatically reports vehicle odometer reading at the beginning and end of the policy term to

[37] See http://www.onstar.com/us_english/jsp/low_mileage_discount.jsp

verify vehicle mileage. Motorist who drive less than specified annual mileage receive insurance premium discounts of up to 40%, as indicated in Table G-9.

Table G-9. Discounts for motorists who drive less than specified annual mileage.

Miles	Discount
1–2,500	40%
2,501–5,000	33%
5,001–7,500	28%
7,501–10,000	20%
10,001–12,500	11%
12,501–15,000	5%
15,001–99,999	0%

Value Pricing Program PAYD Pilot projects [38]

This Federal Highway Administration's Value Pricing Pilot Program is now providing funding for PAYD insurance simulation projects in Georgia and Massachusetts.

Distance-Based Program

Progressive Insurance[39] offers distance-based insurance in Oregon, Michigan, and Minnesota. The program uses GPS to track vehicle location and use.

TripSense(SM)

Progressive also offers a distance and safety-based program: "Safer drivers and people who drive less than average should pay less for auto insurance. That's why we created the revolutionary TripSense(SM) discount program, which measures your actual driving habits and allows you to earn discounts on your insurance by showing us how much, how fast and what times of day you drive. TripSense gives you more control over what you pay for insurance, as your driving habits determine your discount."[40]

Types(s) of GHG Reductions

CO_2

Estimated GHG Reductions and Costs (or Cost Savings)

- **GHG reduction potential in 2010, 2020 ($MMtCO_2e$):** 2.3, 5.3.
- **Cost-Effectiveness:** Expected net savings.
- **Data Sources:** See below.
- **Quantification Methods:**

[38] See http://www.fhwa.dot.gov/policy/13-hmpg.htm
[39] See http://www.progressive.com
[40] See http://tripsense.progressive.com/about.aspx

- VMT impacts: literature. Pilot studies and empirical experience with other marginal costs of use find that PAYD can reduce VMT by between 8% and 20%. If phase in / ramp up, then:

  Apply reductions to LDV VMT only:

  — 2012 reduction = Statewide LDV × 4% reduction = **3.6%** of total statewide HDV + LDV

  — 2020 reduction = Statewide LDV × 8% reduction = **7.2%** of total statewide HDV + LDV

- Convert to CO_2
- Pay-As-You-Drive: The Arizona Public Research Interest Group (PIRG) Education Fund analyzed the potential GHG savings from a Pay-As-You-Drive (PAYD) automobile insurance policy. The strategy for a PAYD policy analyzed assumes that insurers are required to offer mileage-based insurance for certain elements of vehicle insurance, including collision and liability. The PIRG Education Fund assumes the PAYD policy is required, phased in over time, and that all drivers in Arizona are eventually covered.

  To calculate GHG savings, the Arizona Public Research Interest Group Education Fund converted Arizona state automobile collision and liability insurance expenditures to an insurance cost per mile (6.4 cents per mile). If insurance consumers pay 80% of their collision and liability insurance on a per-mile basis, then drivers would be assessed about a 5.1-cent/mile charge. This per-mile insurance charge would reduce vehicle-miles traveled by about 8 %.[41] (To put this charge in context, at 20 mpg, 5.1 cents/mile = ~$1/gallon of gasoline.)

  CCS compared the PIRG Education Fund results for estimated reductions in vehicle miles of travel with other studies of PAYD policies, including those produced by the Economic Policy Institute and Resources for the Future (RFF). CCS found that the AZ PIRG estimates were comparable with other estimates, which ranged from 8 % to 20 %. The 8 % reductions estimates CCS used for estimated reductions in vehicle miles of travel and greenhouse gas emissions reductions fell within the lower range of the comparable estimates.

- Net present value / cost-effectiveness: The success of the Progressive Insurance pilot in Texas, suggests that there is an unmet demand for more choice in auto insurance.

- **Key Assumptions:**
  - State regulation of the North Carolina automobile insurance industry requires insurance companies to offer PAYD insurance

[41] Elizabeth Ridlington and Diane E. Brown, *A Blueprint for Action: Policy Options to Reduce Arizona's Contribution to Global Warming*, Arizona Public Research Interest Group Education Fund, April 2006, pp. 25–26. http://www.arizonapirg.org/AZ.asp?id2=23683. See also: http://www.serconline.org/payd/links.html, which links to a wide variety of PAYD studies and materials.

- Eventual application of PAYD insurance to the entire fleet of North Carolina light-duty motor vehicles.

Key Uncertainties

The specifics of the PAYD insurance programs are to be determined, and the actual effects of PAYD insurance on driver behavior are subject to some significant uncertainty.

Additional Benefits and Costs

Equity Impacts

"Current vehicle insurance pricing significantly overcharges motorists who drive their vehicles less than average each year, and undercharges those who drive more than average within each price class" (Edlin, 1999; Litman, 2001). Since lower-income motorists drive their vehicles significantly less on average than higher-income motorists, this is regressive. Distance-based insurance is fairer than current pricing because prices more accurately reflect insurance costs.

"Distance-based pricing benefits lower-income drivers who otherwise might be unable to afford vehicle insurance, and who place a high value on the opportunity to save money by reducing vehicle mileage. It benefits lower income communities that currently have unaffordably high insurance rates...."[42]

Other equity issues may be addressed through policy design.

Feasibility Issues

None cited.

Status of Group Approval

Approved.

Level of Group Support

Supermajority.

Barriers to Consensus

Concern about impacts on high-mileage drivers.

[42] Todd Litman, "Pay-As-You-Drive Vehicle Insurance: Converting Vehicle Insurance Premiums Into Use-Based Charges," *TDM Encyclopedia*, Victoria Transport Policy Institute, December 2005. http://www.vtpi.org/tdm/tdm79.htm

TLU-12. Advanced Technology Incentives

Mitigation Option Description

Technology will play a vital role in dramatically reducing carbon emissions from the cars of the future. Fuel cells, plug-in hybrid, low weight carbon-fiber bodies, and other technologies will require research, development, and commercialization. Because of its strong research university and both its high-tech and auto parts manufacturing, there may be an opportunity for North Carolina (especially through the Department of Commerce) to encourage advanced automobile technology research and recruit the new generation of manufacturers.

Studies can evaluate if there is an economic opportunity around the development and commercialization of advanced technology vehicles and suggest possible models for the Department of Commerce to take advantage of such opportunities.

Mitigation Option Design

Goals:

- To enable North Carolina's economy to establish itself in the research, development, and commercialization of advanced automotive technologies.
- To grow North Carolina's capacity to recruit sustainable industry.

Timing: Long range (e.g., 10-year) investment plan.

Parties involved:

- North Carolina Department of Commerce
- North Carolina Economic Development Board
- University research programs
- Manufacturers

Other: None cited.

Implementation Mechanisms

- Tax incentives
- Education of industrial recruiters
- Possible formation of a North Carolina Advanced Technology Institute

Related Policies/Programs in Place

There are existing sustainable business recruiting efforts by the Department of Commerce.

Types(s) of GHG Reductions

CO_2.

Estimated GHG Reductions and Costs (or Cost Savings)

By their nature, R&D initiatives cannot be predicted to produce certain kinds of technologies, and hence cannot be predicted to produce certain amounts of emissions reductions. This policy option potentially has substantial upside emissions benefit, but CCS is unable to estimate impacts for this level of policy intent.

Data Sources: Not applicable.

Quantification Methods: Not applicable.

Key Assumptions: Not applicable.

Key Uncertainties

None cited.

Additional Benefits and Costs

None cited.

Feasibility Issues

None cited.

Status of Group Approval

Approved.

Level of Group Support

Unanimous consent.

Barriers to Consensus

None.

TLU-13. Buses – Clean Fuels

Mitigation Option Description

Expand TLU-7 to include transit bus fleets.

Mitigation Option Design

Goals: Included with TLU-6.

Timing: Same.

Parties Involved: Transit bus fleet owners and operators.

Other: None cited.

Implementation Mechanisms

None cited.

Related Policies/Programs in Place

None cited.

Types(s) of GHG Reductions

CO_2.

Estimated GHG Reductions and Costs (or Cost Savings)

Included in TLU-6.

Data Sources: Same.

Quantification Methods: Same.

Key Assumptions: None cited.

Key Uncertainties

None cited.

Additional Benefits and Costs

None cited.

Feasibility Issues

None cited.

Status of Group Approval

Approved.

Level of Group Support

Unanimous consent.

Barriers to Consensus

None.

Appendix H
Agriculture, Forestry, and Waste Management Mitigation Option Recommendations

Summary List of Mitigation Options

	Mitigation Option Name	GHG Reductions ($MMtCO_2e$)			Net Present Value 2007–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of Support*
		2010	2020	Total 2007-2020			
AFW-1	Manure Digesters & Energy Utilization	0.2	0.9	6.4	199	31	UC
AFW-2	Biodiesel Production (incentives for feedstocks and production plants)	0.2	0.8	5.1	286	56	UC
AFW-3	Soil Carbon Management (including organic production methods incentives)	0.2	0.2	3.0	–16	–5	UC
AFW-4a	Preservation of Working Land – Agricultural Land	0.2	0.3	2.6	290	114	UC
AFW-4b	Preservation of Working Land – Forest Land (formerly AFW-7)	1.7	4.3	36	112	3	UC
AFW-5	Agricultural Biomass Feedstocks for Electricity or Steam Production	0.009	0.02	0.2	10	54	UC
AFW-6	Policies to Promote Ethanol Production	0.9	6.9	38	200	5	UC
AFW-7	*Moved to AFW 4a*						
AFW-8	Afforestation and/or Restoration of Non-forested Lands	0.2	2.4	15	128	9	UC
AFW-9&10	Expanded Use of Forest Biomass and Better Forest Management	1.5	5.9	48	–639	–13	UC
AFW-11	Landfill Methane and Biogas Energy Programs	1.1	2.9	20	23	1	UC
AFW-12	Increased Recycling Infrastructure and Collection	0.2	0.5	4.1	4	1	UC
AFW-13	Urban Forestry Measures	1.4	4.3	34	–376	–11	UC
	SECTOR TOTAL AFTER ADJUSTING FOR OVERLAPS	7.8	29	212	222	1	
	REDUCTIONS FROM RECENT ACTIONS (none)	0	0	0	0	0	
	SECTOR TOTAL PLUS RECENT ACTIONS	7.8	29	212	222	1	

* UC = Unanimous Consent (all agree).

AFW-1. Manure Digesters & Energy Utilization Mitigation Option Description

The methane emissions inherent from the anaerobic decomposition process of manure and other wastes may be captured and used as an energy source. In so doing, it is possible to both reduce methane emissions and to offset fossil-based energy. However, the cost of emission capture and energy production can be higher than the value of the energy collected, making this option cost prohibitive for producers operating in a tight margin business. This option covers programs to increase the number of methane capture and energy recovery projects using manure or other waste (including food processor waste).

Mitigation Option Design

Provide economic incentives / cost offsets for producers interested in manure to energy projects.

- **Goals:** Capture 20% of available methane from confined animal operations by 2020 for use in energy projects. The policy is designed to apply to hog farms and dairies in the state.
- **Timing:** By 2010, implement projects to capture 5% of available methane energy at hog farms and dairies. By 2020, implement projects to capture 20% of methane energy.
- **Parties Involved:** NC Farm Bureau, Department of Environment and Natural Resources. (DENR), NC Department of Agriculture and Consumer Services ((NCDA&CS), livestock producers
- **Other:** Due to the levels of emissions and the cost effectiveness estimated for applying this option to livestock operations in NC, this policy is designed to address hog farms primarily and could also cover dairy producers.

Implementation Mechanisms

- Increased education and outreach to farmers regarding the opportunities for manure digesters. Most farmers cannot implement these recommendations without technical assistance. Traditionally, many farmers rely on USDA's Natural Resource Consrvation Service (NRCS) and North Carolina Cooperative Extension Service (NCCES) for this technical assistance. Additional training is needed for the technical assistance providers in order to better promote the technology.
- Incentives in the form of tax breaks (sales and/or income) for incurred capital costs. Current tax incentives are income tax credits up to 50% of tax burden. During the initial stages of this industry, income is likely to be low and therefore income tax credits will be drastically reduced from the maximum allowed. Restructuring the tax credit to allow for greater recovery of the capital costs will provided a greater incentive to install manure digesters. Exempt manure digester equipment from property and/or sales tax. Existing regulations exempt pollution abatement equipment from property tax, similar exemptions are needed for manure digesters.
- Increased funding for voluntary programs such as NC Green Power and NC Agriculture Cost Share to help offset costs of installing and maintaining manure digesters. These existing programs have a limited ability to fund manure digesters through higher electricity payments

(Green Power) and grants for installation costs (Ag Cost Share). Additional funding for these programs is another incremental step in reaching the recommended goal.

- Increased research to improve return on investment for digesters. Technological improvements have the potential to increase efficiency and lower costs thereby making the manure digesters more economically attractive.
- Allow utilities to pay above avoided cost rates for electricity purchased from manure digesters. Currently, utilities are required to pay small power producers the equivalent of what it would cost the utility to generate the electricity. Allowing the utilities to pay above avoided cost will increase the return on installing a manure digester.
- Education for farmers of power purchase agreements and interconnection with the grid. Farmers should be aware of the interconnection standards required by their local utility including the equipment that will be needed as well as any charges that may apply. Power purchase agreements are essentially the contract between the farmer and the utility that includes rates and length of contract. Making these items as simple as possible and educating the farmers about them will enhance the awareness of the procedures needed to provide electricity to the grid.

Related Policies/Programs in Place

- NRCS cost share program.
- NC Renewable Energy Property tax credit. State income tax credit for 35% of construction costs not to exceed $2.5M or 50% of tax burden.[1]
- EPA AgSTAR Program.
- Federal Renewable Electricity Production Tax Credit.
- USDA Farm Bill Renewable Energy and Energy Efficiency Loan and Grant Program - The Renewable Energy and Energy Efficiency loan and grant program was established under Section 9006 of the 2002 Farm Bill. It provides loan guarantees and grants to agricultural producers and rural small businesses for the purchase and installation of renewable energy systems or for energy efficiency improvements. Loan guarantees cover up to 50% of a project's cost, not to exceed $10 million. Grants are available for up to 25% of a project's cost, not to exceed $250,000 for energy efficiency improvements and $500,000 for renewable energy systems. These loans and grants are expected to reduce greenhouse gas emissions by 0.97 million metric tons, replace 821 million barrels of foreign oil and generate almost 2 million kilowatt hours of electricity annually. USDA has funded more than 800 loans and grants since the renewable energy program began in FY 2003.

Type(s) of Green House Gas (GHG) Reductions

- **CH_4:** methane is captured and typically combusted in an energy recovery system or flared. Small amounts of N_2O and CH_4 are emitted from the combustion process.

[1] North Carolina Incentives for Renewable Energy: http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=NC19F&state=NC&CurrentPageID=1&RE=1&EE=0.

- **CO_2:** carbon dioxide is reduced when the methane is converted to energy and that energy is used to offset fossil-based energy (e.g., coal-fired electricity, natural gas, etc.). Small amounts of N_2O and CH_4 are also reduced from the fossil-based energy that is offset.

Estimated GHG Reductions and Costs (or Cost Savings)

- **GHG reduction potential in 2010, 2020 ($MMtCO_2e$):** 0.2, 0.9.
- **Net Cost per $MtCO_2e$:** $32.
  The cost per ton is the weighted average for dairy ($185) and swine ($31). Since only a very small fraction of the emission reductions are achieved at dairies, the weighted cost effectiveness is nearly identical to that estimated for swine operations. Most of the reductions come from the swine sector. For beef feedlots, the cost effectiveness estimate is much higher ($1,641; due to much lower methane emissions/head), so the Technical Working Group (TWG) does not recommend adopting this policy to address feedlots. These cost estimates include the effects of grants for renewable energy projects from the Federal Farm Bill but do not include the effects of other existing federal and state tax incentives.
- **Data Sources:** NC GHG Inventory & Forecast, North Carolina State University (NCSU) technology determinations for swine farms,[2] other technical reports and presentations on implementing digesters at confined animal operations.[3]
- **Quantification Methods:** *GHG Benefit.* Methane emissions data from the I&F was used as the starting point to estimate the GHG benefits of capturing and controlling the volumes of methane targeted by the policy and to add in the additional benefit of electricity generation using this captured methane (through offsetting fossil-based generation). For 2010 and 2020, the GHG benefit for capturing methane was estimated by multiplying the methane emissions from dairy, feedlot, and swine operations by the applicable goal (5% or 20%) and then by an assumed collection efficiency of 75%,[4] and converting to CO_2e.

  The second portion of the GHG benefit for offsetting fossil-based electricity generation was estimated by converting the methane to captured in each year to its heat content (in BTUs) and then multiplying by an energy recovery factor of 17,100 BTU/kW-hr to estimate the electricity produced (assumes a 25% efficiency for conversion to electricity in an engine and generator set). The CO_2e associated with this amount of electricity in

[2] NCSU Animal and Poultry Waste Management Center, Development of Environmentally Superior Technologies: Phase 3 Report Between the Attorney General of North Carolina and Smithfield Foods, Premium Standard Farms, and Frontline Farms, March 8, 2006, information from this study compiled for the Barham swine farm.

[3] Leonard Bull, Animal and Poultry Waste-to-Energy, PowerPoint presentation, North Carolina State University, See http://www.cals.ncsu.edu/waste_mgt/waste%20to%20energy.pdf, accessed June 2006. See also http://www.methanetomarkets.org/resources/ag/docs/animalwaste_prof_final.pdf, accessed March 2006. Williams, Douglas, Valley Air Solutions, presentation "Joseph Gallo Farms Dairy Manure Digester," January 18, 2006. DPNM Biomass Project Final Report, prepared by Agri-Energy and the Dairy Producers of New Mexico, 2005.

[4] The collection efficiency is an assumed value based on engineering judgment. No applicable studies were identified that provided information on methane collection efficiencies achieved using manure digesters (as it relates to collection of entire farm-level emissions).

each year was estimated by converting the kW-hrs to MW-hrs and then multiplying this value by the NC-specific emission factor for electricity production from the I&F (0.542 Mt/MW-hr).

The total GHG benefit was estimated as the sum of both portions of the benefit described above.

Costs

For swine, costs were estimated using annualized costs for the Barham Farm study, which was part of the North Carolina State University (NCSU) technology determinations referenced in the footnote below. Data from this study indicate a range of annualized costs from $18 to $45/head to cover installation and operation of a digester and an engine-generator set/flare. Annual operations and maintenance costs from this study were $8/head. These costs provide an estimate for the implementation of digester and energy projects at swine farms toward the upper end of the range for U.S. projects with documented costs.[5] Capital costs per head were about $72 for Barham Farm compared to an average of $52/head for seven U.S. swine digester to energy projects.

For dairies and feedlots, data from the EPA methane to markets report and Gallo Farms studies referenced below provided an average cost of $450/head for digesters and engine-generator sets (dairies >1,000 head). From the New Mexico Dairy Producers report, capital costs for regional digesters (those serving multiple nearby operations) were estimated to be $190/head. It is not clear based on available data how well regional digesters could be implemented in NC as they require several dairies in close proximity. Therefore, the average of $450/head was used.

CCS assumed that the 25% Farm Bill grant would be available to each project initiated as a result of this policy.[6] After adjustment of the capital costs, annualized costs per head were estimated assuming a 5% interest rate and a 15-year project life, annual operations and maintenance costs of $38/head were taken from the Gallo Farms Study, and the value of the electricity produced was assumed to be $0.05/kW-hr. Additional incentives to the farmer from the Renewable Energy Production Incentives were not included but could have a small effect on the estimated costs (about $1/Mt$CO_2$e reduced). The annualized per head cost estimates were multiplied by the head of livestock to be controlled in each year to estimate total costs.

- **Key Assumptions:** That the cost data for the studies cited is representative of actual costs; 75% collection efficiency for farm-level methane emissions for the digester. Farm Bill grant will be available to all projects in subsequent cycles of the Farm Bill through 2020. The $0.05/kWh is the assumed value to the farmer for the electricity produced (either to offset on-farm use or to sell back to the grid); this is a conservative estimate.

[5] Moser, M., "A Dozen Successful Swine Waste Digesters", RCM Digesters, Inc., accessed February 2007 at: http://rcmdigesters.com/images/PDF/ADozenSuccessfulSwineWasteDigesters.pdf.

[6] More information on the program is also available at: http://www.rurdev.usda.gov/rbs/farmbill/index.html. The application of this grant incentive was considered a reasonable assumption based on CCS discussions with EPA AgSTAR Program staff; Kurt Roos, personal communication with S. Roe, CCS, March 2007.

Higher values for this electricity would translate into a lower cost effectiveness estimate and a faster return on investment for the farmer.

Key Uncertainties

See key assumptions in the quantification section above.

Additional Benefits and Costs

- *Air & Water Pollution Impacts* - Reductions in emissions of ammonia, volatile organic compounds, and odors (sulfur compounds) are achievable. Reductions occur when anaerobic digesters and energy utilization are used to capture emissions that would have occurred from the lagoon surface. Note that these reductions occur at the lagoon surface and that there is a potential for increased ammonia emissions during application of digester effluent to fields due to high ammonium concentrations, if measures are not taken to avoid these emissions. Ammonia emissions are important in the formation of fine particulate matter and nitrogen deposition to sensitive water sheds. Also, there will be an increase in emissions of nitrogen and sulfur oxides during the combustion of biogas. Both of these pollutants are also fine particulate matter precursors, and oxides of nitrogen are a precursor of ozone.

  Measures to reduce both air and water pollution impacts could include the use of nitrifying/denitrifying systems to reduce the ammonium concentration prior to application. In these systems, ammonium is converted to nitrogen which is released instead of ammonia. (Care must be taken to avoid excessive nitrous oxide emissions, however.) The other option is to identify and produce marketable products from the digester effluent, which would have to be trucked off the farm. The increased GHG emissions associated with transporting any such products have not been factored in to the analysis conducted for this option.

  A study of an anaerobic digester project for a dairy farm[7] demonstrated that these projects can substantially reduce total volatile solids (39.5%) and chemical oxygen demand (38.5%). These reductions translate directly into a lower potential for depletion of dissolved oxygen in natural waters. Although anaerobically digested manure is not suitable for direct discharge to surface or ground waters, these reductions still are significant due to the potential for these wastes to enter surface waters by nonpoint source transport mechanisms. The study also showed that mesophilic anaerobic digestion at an average hydraulic retention time of 29 days reduced the mean densities of the fecal coliform group of enteric bacteria by 99% and fecal streptococcus group by 90%;

- Possible nutrient management benefits for situations where ammonium-rich effluent can be used without excessive ammonia emissions;
- Economic benefits for the digester industry.

Feasibility Issues

- Currently a long return on investment.

[7] "An Evaluation of a Mesophilic, Modified Plug Flow Anaerobic Digester for Dairy Cattle Manure", prepared by Eastern Research Group, prepared for the U.S. EPA AgSTAR Program, July 20, 2005.

- Demand from electric utilities and other entities seeking renewable energy sources.
- Utility barriers including grid interconnection and electricity standby costs charged to the farmer.

Status of Group Approval

Complete

Level of Group Support

Unanimous

Barriers to Consensus

None

AFW-2. Biodiesel Production (Incentives for Feedstocks and Production Plants)

Mitigation Option Description

Use of biodiesel offsets the consumption of diesel fuel produced from oil (fossil diesel). Since biodiesel has a lower GHG content than fossil diesel, overall GHG emissions are reduced. By producing biodiesel in the state for consumption within the state, the highest benefits can be achieved, since the fuel is transported over shorter distances to the end user. This option covers incentives needed to increase biodiesel production in North Carolina.

Note: This option is linked with Transportation & Land Use (TLU) Option 7 on Biofuels. This option seeks to achieve incremental GHG benefits beyond the TLU option by promoting in-state production of biodiesel using feedstocks with greater GHG benefits than the likely business as usual national production methods. In addition, NC consumption of biodiesel produced in-state will produce better GHG benefits than biodiesel obtained from a national market due to lower embedded CO_2 associated with transportation of biodiesel or its feedstocks from distant sources.

Mitigation Option Design

- **Goals:** Produce enough biodiesel to offset 12.5% of NC's fossil diesel consumption by 2020.
- **Timing:** By 2010, produce enough biodiesel to offset 5% of fossil diesel consumption. By 2020, produce enough biodiesel to offset 12.5% of in-state fossil diesel consumption.
- **Parties Involved:**. NCDA&CS, Department of Administration, Motor Carrier Enforcement Division, DENR, Department of Commerce, NC Rural Center, NCSU, North Carolina Agricultural & Technical State University (NCA&T), other state agencies, agricultural associations which represent producers of feedstock, petroleum industry trade groups, and various industry associations.
- **Other:** NA

Implementation Mechanisms

- Incentives in the form of grants or tax breaks (sales and/or income) for incurred capital costs for feedstock producers (oil crops, methanol/ethanol).
- Streamlined permitting of production facilities. Technical assistance for new producers.
- Incentives and grants for expanded research for oilseed production and processing (including canola and other crops not typically grown in NC).
- Active solicitation of new producers.
- Expanded consumer education to drive demand.
- Expanded producer education to develop skilled workforce.

Related Policies/Programs in Place

- NC Renewable Energy Property tax credit. State income tax credit for 35% of construction costs not to exceed $2.5M or 50% of tax burden.
- Federal Biodiesel Mixture Tax Credit. Federal excise tax credit for biodiesel mixtures, ranges from $0.50 to $1.00/gallon depending on feedstock.

Type(s) of GHG Reductions

- **CO_2:** Lifecycle emissions are reduced to the extent that biodiesel is produced with lower embedded fossil-based carbon than conventional (fossil) diesel fuel. Feedstocks used for producing biodiesel can be made from crops, which contain carbon sequestered during photosynthesis (e.g., biogenic or short-term carbon). The primary feedstocks are vegetable oils (soy, canola, sunflower, algal, etc.) and alcohols (either methanol or ethanol). From a recent report (Hill et al., 2006),[8] biodiesel from soybeans contains 93% more useable energy than its petroleum equivalent and reduces lifecycle GHG emissions by as much as 41%. Higher oil production potential of different feedstocks (e.g., other oil crops, algae) will likely adjust the lifecycle GHG emissions further downward as they are developed as biodiesel sources. Local production of biodiesel also decreases the embedded CO_2e of biodiesel compared to importation of out of state vegetable oil supplies.

Estimated GHG Reductions and Costs (or Cost Savings)

- **GHG reduction potential in 2010, 2020 ($MMtCO_2e$):** 0.2, 0.8.
- **Net Cost per $MtCO_2e$:** $56.
- **Data Sources:** Data from the NC Inventory & Forecast were the starting point for quantifying the benefits of offsetting fossil diesel consumption with biodiesel produced within the state (these do not incorporate future reductions in consumption due to TLU options). Fossil diesel consumption estimates are shown in Table H-1 (under business as usual).

Table H-1.

Year	Diesel Consumption (MMgal/yr)
2010	1,470
2020	2,157

The policy design calls for 5% of the fossil diesel consumption to be offset by 2010 from in-state production and 12.5% offset by 2020. Biodiesel production targets are shown in Table H-2.

[8] Hill et al, 2006, "Environmental, economic, and energetic costs and benefits of biodiesel and ethanol biofuels," *Proceedings of the National Academy of Sciences*, volume 103, pp. 11206-11210, July 25, 2006.

Table H-2.

Year	Biodiesel Production Needed (MMgal/yr)
2010	71
2020	259

By 2010, "business as usual" (BAU) biodiesel production in the state is expected to be 3 MMgal.[9] By projecting the 2007 to 2010 BAU production growth rate (0 to 3 MMgal/yr), the estimated 2020 BAU production level would be 10 MMgal/yr. Hence, by 2020, this option would try to increase the production levels to about 249 MMgal/yr (see Table H-3.

Table H-3.

Year	Biodiesel Production Needed Beyond BAU (MMgal/yr)
2010	68
2020	249

The CO_2e emission factor for fossil diesel used in the inventory and forecast is 10.04 Mt/1,000 gallons. The lifecycle fossil diesel emission factor is 12.3 Mt/1,000 gallons (Hill et al., 2006; cited in the footnotes).

- **Quantification Methods:**

  GHG Reductions

  A new study on lifecycle GHG benefits for biodiesel production and use was used to estimate the CO_2e reductions for this option (Hill et al, 2006; cited in footnotes to this option). This study covered biodiesel production from soybean production, which is currently the predominant feedstock source for biodiesel production in the US and is assumed to remain that way for the purposes of this analysis. (It is also the predominant source of vegetable oil production in NC.) Lifecycle CO_2e reductions (via displacement of fossil diesel with soybean-derived biodiesel) were estimated by Hill et al to be 41%. This value is being used by the TLU TWG to estimate the benefit of the biodiesel component of the TLU biofuels option. Hence, this analysis focuses on incremental benefits of in-state feedstocks production with the focus on vegetable oils.

  For this option, the incremental benefit of in-state production is derived from the lower embedded GHG content of biodiesel feedstocks (vegetable oil) avoided from having to transport the feedstocks from their likely source region. For this assessment, the likely source regions for soybean or canola oil are the U.S. mid-west or northern plains regions. Using South Dakota as a potential source region, rail transport would require shipments

[9] www.eere.energy.gov/states/state_news_detail.cfm/news_id=10298/state=NC; USDOE Energy Efficiency and Renewable Energy website, accessed 1/16/07; Piedmont Biofuels begins operation in late 2006 (1 MMgal/yr capacity); one of three plants being built in NC; assume similar capacity for the remaining two and that these will be operational by 2010.

to central North Carolina of about 1,400 miles.[10] Rail fuel consumption is about 400 ton-miles/gallon.[11] The density of vegetable oil is about 3,700 tons/MMgal. From these inputs, a GHG emission rate of 130 $MtCO_2$/MMgal oil was calculated.

When combined with the other feedstocks needed to produce biodiesel (e.g., either methanol or ethanol),[12] a gallon of vegetable oil will produce slightly more than one gallon of biodiesel. For the purposes of this estimate, each gallon is assumed to produce one gallon of biodiesel.

In addition to soybean oil, other oil feedstocks included in this analysis include animal oils (yellow grease, poultry fat, lard, and tallow), canola, and algal oils. As mentioned under the feasibility section below, current production of these feedstocks in NC would not meet the goals of the proposed policy (no canola or algal oils are currently produced). Even after substituting canola production for all of the current wheat production in NC, the 2020 production goal would not be met. Hence, it is assumed that technology advances will occur during the policy period that will allow for commercial scale production of algal oil to make up the shortfall (e.g., in the post-2015 period). With sufficient technology advancement, another option could be Fischer-Tropsch biodiesel from cellulose.

For oil sources other than soybean oil, the benefit for substituting in-state biodiesel for fossil diesel is estimated starting with the lifecycle soybean emission factor (7,261 $MtCO_2e$/MMgal from the Hill et al study). As mentioned previously, the benefits of the biodiesel component of the TLU biofuels option is based on displacement with soybean-based biodiesel. Hence, this analysis was designed only to account for the incremental benefit of in-state feedstock (oil) production using GHG preferential feedstocks. These include vegetable oils that produce greater volumes of oil per unit of energy input (e.g., canola), animal fats, and, in the future, algal oils.

Canola produces 127 gallons of oil per acre compared to soybeans at 48 gallons/acre. Assuming canola production energy inputs are not significantly greater than soy, the lifecycle emission rate for canola would be 7,261 x 48/127 or 2,744 $MtCO_2e$/MMgal. So the incremental benefit of canola over soy is 7,261 - 2,744 = 4,517 $MtCO_2e$/MMgal.

For animal fats and algal oils, CCS assumes that these have negligible embedded energy. So the incremental benefit over soy equals the lifecycle fossil diesel emission factor (EF) (12,306 $MtCO_2e$/MMgal) minus the soybean based EF (7,261 $MtCO_2e$/MMgal), which is 5,045 $MtCO_2e$/MMgal.

To meet the in-state production goals for 2010 and 2020, Table H-4 provides the mix of oil feedstocks assumed in this analysis. The assumed mix relies heavily on new technologies (e.g., algal oil) to produce feedstocks in the post-2010 period. The new production data summarized below exclude BAU production, which is estimated to be 3

[10] U.S. National Atlas, at http://nationalatlas.gov/natlas/Natlasstart.asp.

[11] U.S. National Atlas, at http://nationalatlas.gov/articles/transportation/a_freightrr.html.

[12] While the analysis here focuses on the primary feedstock for biodiesel, vegetable oil, the policy should also promote the production and use of alcohol feedstocks produced from renewable resources (e.g., starch or cellulosic ethanol, renewable methane to methanol).

MMgal/yr in 2010 and 10.3 MMgal/yr in 2020[13] (BAU production is further assumed to be soybean-based with little incremental benefit above the TLU Option 6 benefit).

Table H-4.

Year	Oil Feedstock	Fraction of New Production	MMgal/yr Needed*
2010	Soy	0.40	27
2010	Canola	0.10	7
2010	Animal	0.50	34
2010	Algal	0.00	–
		2010 Total	**68**
2020	Soy	0.12	30
2020	Canola	0.25	62
2020	Animal	0.20	50
2020	Algal	0.43	107
		2020 Total	**249**

* Excludes BAU production estimated to be 3 MMgal/yr in 2010 and 10.3 MMgal/yr in 2020.

GHG reductions were estimated by multiplying the production of each oil feedstock by the applicable incremental benefit (e.g., by oil type). Total reductions in each year were estimated by summing the incremental benefit for each oil type.

Costs

Costs were estimated using information from an analysis of biodiesel production costs from the US DOE.[14] The value of incentives needed is assumed to be equivalent to the difference in the costs of producing fossil diesel and soy-based biodiesel ($0.34/gallon). This value is very close to the incentive offered in a State of Missouri incentives program.[15] This program offers production incentives of $0.30/gallon to producers up to 15 million gallons of production/yr. The incentive grants last for five years.

CCS assumed a similar incentive structure and that these would cover the costs of all grants or tax incentives associated with this policy (all other implementation mechanisms are assumed to be achieved within existing programs). The cost estimates are based on multiplying the amount of biodiesel produced in each year by the production incentive. This assumes that all production occurs at production facilities of less than 15 million gallons/yr. The production incentive runs out after five years of production.

[13] See www.eere.energy.gov/states/state_news_detail.cfm/news_id=10298/state=NC, USDOE Energy Efficiency and Renewable Energy; Piedmont Biofuels begins operation in late 2006. One of three plants being built. Assume similar capacity for the remaining two to be operational by 2010. After 2010, assumes BAU growth is at the estimated 2007-2010 growth rate (0.7 MMgal/yr).

[14] See www.eia.doe.gov/oiaf/analysispaper/biodiesel/index.html; accessed January 2007.

[15] Information on the Missouri Program: www.newrules.org/agri/mobiofuels.html#biodiesel, accessed January 2007.

- **Key Assumptions:** Life-cycle GHG emission factors utilized/derived for this analysis are representative for each feedstock and for fossil diesel. Production incentives offered by this option are sufficient to drive production of GHG-superior feedstocks (e.g., superior to soybeans) and to increase the level of research and development needed for non-crop based feedstocks (e.g., algal biodiesel, Fischer-Tropsch biodiesel).

Key Uncertainties

Pending

Additional Benefits and Costs

- Additional markets for oilseed crops and animal fats.
- Economic growth from locally produced fuels.

Feasibility Issues

Current production of biodiesel feedstocks in NC are provided in Table H-5.[16]

Table H-5.

	Million gallons per year
Soy oil	60.5[17]
Canola oil	0
Yellow grease	10
Poultry fat	21
Lard	21
Tallow	2
Total Current Feedstocks	**114.5**

By converting all NC wheat to canola production, another 66 MMgal/yr could be produced,[18] yielding a total of about 180 MMgal/yr. Given that the policy requires about 250 MMgal/yr by 2020, these data show the importance of additional research and development and production incentives for other non-crop sources of biodiesel feedstock oil. These include production of oil from algae and Fischer-Tropsch biodiesel from cellulose.

Status of Group Approval

Complete

Level of Group Support

Unanimous

Barriers to Consensus

None

[16] Henry Tsai, economist, NCSU Solar Center, 2004 slideshow, "Implications of Rising Energy Cost on the Economy: 3 Different Perspectives."

[17] NC Biomass Resource Inventory 2003. This oil production figure was calculated based on 43,200,000 bushels of soy grown in North Carolina.

[18] Kurt Creamer, North Carolina State University, personal communication with S. Roe, CCS, January 16, 2007.

AFW-3. Soil Carbon Management

Mitigation Option Description

Use of conservation tillage, no-till methods, cover cropping, and other soil management practices can increase the level of organic carbon in the soil, which sequesters carbon dioxide. In addition, some practices lower fossil fuel consumption through less intensive equipment use. Other practices, such as the application of bio-char can also increase the level of soil carbon and improve the soil.

Another element of this option is the promotion of certified organic production techniques. A number of studies have found that organic production of row crops result in GHG benefits, including higher levels of soil organic carbon, relative to conventional production methods. This option is designed to increase the acreage using soil management and production practices that lead to higher soil carbon content and other GHG benefits.

Mitigation Option Design

- **Goals:** By 2020, apply soil management practices on 50% of cultivated lands that currently do not use these techniques. Also, identify and promote organic production techniques that have been demonstrated in NC to achieve net GHG benefits.
- **Timing:** By 2010, apply soil management practices on 20% of acres that currently do not use these practices. Achieve an increase to 50% of these acres by 2020. By 2010, complete a systematic assessment of organic cultivation systems for NC crops and identify those that achieve net GHG benefits. Initiate programs to promote these organic cultivation methods through 2020.
- **Parties Involved:** NC Department of Agriculture (CEFS), NC Department of Environement and Natural Resources (DENR), NCSU (CALS, CNR), NC Extension, other agricultural organizations and associations.
- **Other:** Studies in NC have found the potential to sequester one ton of carbon per acre through conservation tillage/no-till practices over a six-year period[19] (equivalent to about 3.3 $MtCO_2e$/acre). Studies in California[20] and Pennsylvania[21] have shown that certified organic production methods of row crops sequester dramatically more carbon than

[19] Available at http://southeastfarmpress.com/news/030106-Naderman-conservation/.

[20] Source: *Conservation tillage and cover cropping influence soil properties in San Joaquin Valley cotton-tomato crop,* by Jessica J. Veenstra, William R. Horwath, Jeffrey P. Mitchell and Daniel S. Munk. California Agriculture Journal, July-Sept. 2006.

[21] Chapter in book: "The Rodale Institute Farming Systems Trial 1981 to 2005: Long Term Analysis of Organic and Conventional Maize and Soy-bean Cropping Systems," pp15-30, in *Long Term Field Experiments in Organic Farming*, edited by J Rauppe, C Perkrun, M Oltmanns, U Kopke. ISOFAR - International Society of Organic Agricultural Research, Verlaug Publishing, Berlin, 2006.

conventional practices. Both studies independently concluded that fully-tilled organic production can sequester 1000 lbs per acre per year.[22] Soil carbon accumulations up to 28,000 lbs per acre were observed in the 25-year field trial performed at the Rodale Institute.

A recent study in the United Kingdom[23] found that some organic production techniques have higher energy inputs or land requirements than conventional techniques (sometimes due to lower yields, longer production cycles for livestock like poultry). Because increases in soil carbon content do not fully reflect crop production cycle GHG emissions (due to changes in tillage practices, application of chemicals, etc.), research and pilot studies will be needed to determine which organic cropping systems in NC achieve net GHG benefits (see Feasibility Issues section below).

Implementation Mechanisms

- Increase NC Agriculture Cost Share funding to include additional acreage in no-till and organic farming techniques.
- Create a Cost Share program to help producers through the process of organic certification.
- Expand educational programs through NCCES on conservation tillage and certified organic production techniques.
- Research the organic production systems suitable for North Carolina that produce net GHG benefits. Actively promote penetration of organic production methods within these systems.
- Research the availability and effectiveness of bio-char application.
- Research the need for infrastructure to facilitate in-state farmers moving their organically produced goods to market.
- Incentives in the form of grants, tax breaks, or loan guarantees for development of infrastructure needed for certified organic commodities and crops.

Related Policies/Programs in Place

- NC Agriculture Cost Share Program for no-till; $125/acre with a 120-acre cap for switching to no-till for 5 consecutive years.
- NRCS cost share programs.

Type(s) of GHG Reductions

- **CO_2:** Reducing tillage and soil disturbance slows the breakdown of plant material on the soil surface and in the root zone, accelerating the microbial processes that stabilize carbon and protecting carbon from oxidation, inhibiting the release of carbon back into

[22] Source: Interview with Dr Paul Hepperly, Rodale Institute, February 8, 2007.

[23] *Environmental Impacts of Food Production and Consumption,* Manchester Business School, prepared for the Department for Environment, Food and Rural Affairs, December 2006, http://www.defra.gov.uk/science/project_data/DocumentLibrary/EV02007/EV02007_4601_FRP.pdf.

the atmosphere. Depending on how the adoption of conservation tillage and organic production methods affects the overall crop production cycle, additional CO_2 reductions can occur through lower fossil fuel consumption in farm equipment. Note that some studies have shown higher fuel consumption using organic techniques than conventional production. Also, organic production methods reduce GHG emissions associated with the production, transport, and application of pesticides, herbicides, and other chemical treatments.

- **N_2O:** To the extent that fossil fuel consumption is lowered through the cultivation methods implemented under this policy, N_2O emissions from fuel combustion will be lowered. *It is important to note that research also indicates the potential for higher N_2O emissions as soil organic carbon levels increase* (see Feasibility Issues Section below).
- **CH_4:** To the extent that fossil fuel consumption is lowered through the cultivation methods implemented under this policy, CH_4 emissions from fuel combustion will be lowered.

Estimated GHG Reductions and Costs (or Cost Savings)

- **GHG reduction potential in 2010, 2020 ($MMtCO_2e$):** 0.2, 0.1.
  Note: The GHG reductions above and costs below do not reflect the organic production incentives elements of this option. Because agricultural soils will only accumulate carbon up to a certain level before tapering off, the GHG benefit decreases in the post-2020 period to about 0.05 $MMtCO_2e$/yr after 2025. The remaining benefit, which is permanent, is associated with lower fossil fuel consumption.
- **Net Cost per $MtCO_2e$:** -$5.
- **Data Sources:** Agricultural soil carbon accumulation levels were taken from a 2006 study by Naderman et al.[24] This study found a range of soil carbon accumulation in different NC cropping systems of 1,000-3,000 lb/acre. These accumulations occurred following a period of six consecutive years of no-till farming. Data on current (2004) acres of cropland where conservation till/reduced till practices are employed were taken from the Conservation Technology Information Center (CTIC).[25] These data show that NC had 4,234,965 planted acres in 2004. In 2004, 2,292,104 acres were cultivated using conservation tillage or reduced tillage methods.

  The reduction in fossil diesel fuel use from the adoption of conservation tillage methods is 3.5 gallons/acre.[26] From the NC Inventory & Forecast, the fossil diesel GHG emission factor is 8.37 $MtCO_2e$/1,000 gallons.

  Adoption of conservation tillage/no-till practices are estimated to result in a cost savings for the grower. Work by NCSU on applying these practices to cotton growing in NC

[24] Naderman, G., B.G. Brock, G.B. Reddy, C.W. Raczkowski, *Long Term No-Tillage: Effects on Soil Carbon and Soil Density Within the Prime Crop Root Zone*, Project Report, NCSU, January 2006.

[25] 2004 CTIC data provided by Paul Sherman of the NC Farm Bureau, February 2006.

[26] Reduction associated with conservation tillage compared to conventional tillage, at http://www.ctic.purdue.edu/Core4/CT/CRM/Benefits.html, accessed August 2006.

resulted in a range of cost savings from about $3 to $14 per acre per year.[27] CCS used the low end of the range as a conservative estimate of cost savings for this policy option. An older cost study for no-till versus conventional tillage methods for corn and soybeans in NC showed significant cost savings for no-till methods for most cropping systems and tillage methods ($5-$20/acre).[28] Given that these were based on 1981 data (including fuel prices), the cost savings in today's dollars would be much larger. No additional cost benefits were incorporated for the cost share programs noted above.

- **Quantification Methods:** Based on the policy design parameters, the schedule for acres to be put into conservation tillage/no-till cultivation are shown in Table H-6. The mid-point of the estimated range for carbon sequestration (2,000 lb/acre) in NC agricultural soils was used to estimate the total amount of carbon to be sequestered. Based on the Naderman et al study referenced above, it was further assumed that this additional carbon would be sequestered in the soil over a period of six years (after six years no further carbon is stored). The resulting annual carbon accumulation rate was converted into its CO_2 equivalent yielding 0.55 $MtCO_2$/acre-yr.

  To estimate carbon stored each year, the annual accumulation rate was multiplied by the number of acres in the policy program each year. After six years, the crop acres that entered the program were assumed to not store additional carbon. Results are shown in Table H-6.

  Additional GHG savings from reduced fossil fuel consumption were estimated by multiplying the fossil diesel emission factor and diesel fuel reduction per acre estimate provided above. Results are shown in Table H-6 along with a total estimated benefit from both carbon sequestration and fossil fuel reductions.

  Costs were estimated by multiplying the estimated savings per acre cited above ($3) by the number of acres in the program each year. The effects of other existing incentive programs were not taken into account in these estimates.

- **Key Assumptions:**

  These include: the of the assumed carbon sequestration potential is representative across all of the crop systems to which the policy is applied; a six-year period for accumulating the soil carbon; no additional significant accumulation of soil carbon after six years; any potential increase in N_2O emissions (see Feasibility Section below) is not large enough to significantly effect the estimated benefits; the cost savings is a representative average of savings to be achieved across all crop systems.

[27] $3-$14/acre savings dependent on comparison of no-till to either strip till or conventional tillage. From: Economic Comparison of Three Cotton Tillage Systems in Three NC Regions, S. Walton and G. Bullen, NCSU, atwww.ces.ncsu.edu/depts/agecon/Cotton_Econ/production/Economic_Comparison.ppt, accessed February 2007.

[28] *No-Till Crop Production Systems in North Carolina – Corn, Soybeans, Sorghum, and Forages*, North Carolina Agricultural Extension Service, date unknown, accessed February 2007, at www.ag.auburn.edu/aux/nsdl/sctcsa/Proceedings/1981/1981_SCTCSA.pdf.

Table H-6. Assumed Schedule for Adoption of Conservation Tillage/No-Till Practices and Associated Benefits

Year	Acres in Program	Acres still accumulating carbon	$MMtCO_2e$ Sequestered	Diesel Saved (1,000 gal)	Diesel GHG avoided ($MMtCO_2e$)	Total $MMtCO_2e$ saved
2007	97,393	97,393	0.054	341	0.0029	0.0568
2008	194,786	194,786	0.108	682	0.0057	0.1137
2009	306,788	306,788	0.170	1,074	0.0090	0.1791
2010	389,572	389,572	0.216	1,364	0.0114	0.2274
2011	448,008	448,008	0.248	1,568	0.0131	0.2615
2012	506,444	506,444	0.281	1,773	0.0148	0.2956
2013	564,880	467,487	0.259	1,977	0.0166	0.2757
2014	623,316	428,530	0.238	2,182	0.0183	0.2558
2015	681,752	374,964	0.208	2,386	0.0200	0.2279
2016	740,188	350,615	0.194	2,591	0.0217	0.2161
2017	798,624	350,615	0.194	2,795	0.0234	0.2178
2018	857,059	350,615	0.194	3,000	0.0251	0.2195
2019	915,495	350,615	0.194	3,204	0.0268	0.2212
2020	973,931	350,615	0.194	3,409	0.0285	0.2229
2021	973,931	292,180	0.162	3,409	0.0285	0.1905
2022	973,931	233,744	0.130	3,409	0.0285	0.1581
2023	973,931	175,308	0.097	3,409	0.0285	0.1257
2024	973,931	116,872	0.065	3,409	0.0285	0.0933
2025	973,931	58,436	0.032	3,409	0.0285	0.0609
2026	973,931	0	0.000	3,409	0.0285	0.0285
2027	973,931	0	0.000	3,409	0.0285	0.0285
2028	973,931	0	0.000	3,409	0.0285	0.0285
2029	973,931	0	0.000	3,409	0.0285	0.0285
2030	973,931	0	0.000	3,409	0.0285	0.0285

Key Uncertainties

See "key assumptions" in the previous section. Note that the benefits and costs of the application of bio-char to agricultural soils have not been included in this analysis. Within the period of analysis for this policy, bio-char application could become another element of this program to increase soil carbon levels in agricultural soils.

Additional Benefits and Costs

Organic production under offers considerable economic market benefits: Certified producers are receiving premium prices for their harvests.

The dramatic increases in soil carbon with certified organic production methods offer further benefit in periods of drought or extreme rain. The Rodale Farming Systems Trial has quantified

superior crop production during droughts, compared to conventional no-till production, because soils in the organic plots captured more water and retained more of it in the crop root zone than in the conventional no-till plots. During torrential rains, water capture in the organic plots was approximately 100% higher than in conventional no-till plots.[29]

Feasibility Issues

The goal of expanding organic production by 10% is modest and feasible, and has been easily beaten by our foreign competitors: During the period of 2002 to 2006, China's certified organic acreage grew 8,650% (from 40,000 to 3.5 million); Uruguay, 58,285% (1,300 to 759,000); Chile, 1,200% (3,000 to 39,000); and Mexico 243% (86,000 to 295,000). The growth in Uruguay, Chile, and Mexico was entirely driven by market demand, not subsidies or policies.[30]

Our acreage goal has been easily achieved and surpassed by other states in the USA: From 2000 to 2005 California's total certified organic acreage of cropland grew from 141,000 to 223,000, a more than doubling.[31]

Research has indicated a potential for increased N_2O emissions as soil organic carbon levels increase.[32] Additional study and field work on NC cropping/soil systems will be needed to verify the GHG reduction potential estimated in this policy analysis for no till cultivation.

More importantly, additional study of organic production systems applicable to NC is needed to determine full crop production cycle GHG benefits. Known benefits for organic production systems include:

- *CO_2 Capture*: cover crops used in organic production actively capture atmospheric CO_2, and full-tilling incorporates it into the soil deeper and faster than conventional no-till. Organic production methods cause crops to grow more root mass, deeper than with conventional methods, creating deeper accumulation of soil carbon, allowing for greater long-term accumulation.[33]
- *Avoided CO_2 Release*: by using animal manure, compost, and cover crops as fertilizers, certified organic production methods do not oxidize the soil carbon as nitrogen fertilizer does. The lime applied to adjust the pH actually releases CO_2.[34]

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[29] Source: *"The performance of organic and conventional cropping systems in an extreme climate year,"* D.W. Lotter, R. Seidel, and W. Liebhardt, Rodale Institute, American Journal of Alternative Agriculture, September 2003, vol. 18, no. 3, pp. 146-154(9).

[30] Source: *"The World of Organic Agriculture: Statistics & Emerging Trends 2006,"* by Helga Willer and Minou Yussefi, IFOAM (International Federation of Organic Agriculture Movements), 2006, Bonn, Germany. http://orgprints.org/5161/01/yussefi-2006-overview.pdf

[31] Source: Interview with Catherine Greene, USDA Economic Research Service, February 8, 2007.

[32] Li et al., "Carbon Sequestration in Arable Soils is Likely to Increase Nitrous Oxide Emissions, Offsetting Reductions in Climate Radiative Forcing" *Climate Change*, (2005) 72: 321–338.

[33] Source: Interview with Dr. Paul Hepperly, Rodale Institute, February 8, 2007.

[34] Source: Interview with Dr. Paul Hepperly, Rodale Institute, February 8, 2007.

- *Avoided GHG Emissions in Production of Inputs*: nitrogen fertilizer, pesticides, and herbicides used in conventional agriculture (including conventional no-till), require process energy and petro-chemicals in their production. Organic production methods grow their fertilizers (or use manures and composts), and control weeds and pests in ways that have a lower life-cycle energy cost.[35]
- *Greater Overall Soil Carbon and GHG Benefits*: No-till conventional uses more energy and produces more CO_2 than full-tillage organic row crop production with cover crops. The energy burned in diesel fuel is less than the embodied energy in the avoided fertilizer and lime.[36]

Recent study in the United Kingdom found that in many but not all organic production systems that net GHG emissions were reduced.[37] Organic farming's weaknesses were identified as: 1) similar inputs into the farm including manufacture/operation of machinery and packaging; 2) in some cases, significantly lower yields resulting in higher GHG emissions per ton of product; and 3) slower maturing of animals (more GHG per ton product).

It will be important for NC to study and identify the organic production systems best suited to the state and that produce net GHG benefits. In conjunction with implementation of this policy NCSU's Agronomy Division, Soil Testing Service, can provide the service of soil carbon measurements on the soil samples certified producers are already required to submit.

Status of Group Approval

Complete

Level of Group Support

Unanimous

Barriers to Consensus

None

[35] Environmental, Energetic and Economic Comparisons of Organic and Conventional. Farming Systems, David Pimentel, Paul Hepperly, James Hanson, David Douds, Rita Seidel. *BioScience*, July 2005 / Vol. 55 No. 7.

[36] Source: Interview with Dr. Paul Hepperly, Rodale Institute, February 8, 2007.

[37] Melchett, P., "One planet agriculture – the strengths and weaknesses of organic food and farming", Soil Association Conference 2007, January 26, 2007, http://www.soilassociation.org.uk/Web/SA/saweb.nsf/cfff6730b881e40e80256a6a002a765c/902f12def991d13a80256f9c005e300e/$FILE/conference_melchett.pps.

AFW-4a. Preservation of Working Lands – Agricultural Land

Mitigation Option Description

Reduce the rate at which existing crop and pasture are converted to developed uses. The carbon sequestered in soils and aboveground biomass is much higher in croplands than in developed land uses. Policies are needed to preserve working farms and forests (see AFW-4b) from unwise and unplanned development. This option should be seen as a companion measure to TLU-1a (Land Development Planning).

Mitigation Option Design

State and national programs have been established to protect farm communities from conversion to development. Funding state farmland preservation programs will help meet goals and act as a needed match to national programs. Programs are being investigated that help farmers transition lands to beginning farmers.

- **Goals:** Reduce the rate at which agricultural lands are converted to developed use by 50% by 2020 from current levels.
- **Timing:** By 2010, reduce the rate of conversion by 20% from current levels. By 2020, reduce the rate of conversion by 50%.
- **Parties Involved:** NCDA&CS, NC Farm Bureau, NCDF, USDA-Forest Service, NC Dept. of Forest Resources (NCDR), NCSU, and NC Farm Transition Network.
- **Other:** North Carolina lost 5,500 farms and 300,000 acres between 2003-2006.[38]

Implementation Mechanisms

- Increased funding for state farmland preservation programs.
- Increased public education on the benefits of preserving agricultural land.
- Inclusion in voluntary programs such as NC Agriculture Cost Share.
- Increased funding from General Funds.
- Increase funding for Agricultural Development and Farmland Preservation Trust Fund (protects forest and farmlands).
- Farm Bill Conservation Title- EQIP, CRP, CREP.
- Encourage counties to construct County Farmland Protection Plans in order to identify and plan to protect their farm and forestland production areas.
- Engage local governments and nongovernmental organizations on recruiting farmers to take part in protection programs and in developing funding mechanisms to support the plans.

[38] Max Merrill, NCDA&CS, personal communication with S. Roe, CCS, March 15, 2007.

Related Policies/Programs in Place

- Agricultural Development and Farmland Preservation Trust Fund.
- Present Use Tax Valuation.
- North Carolina Conservation Tax Credit.
- Farm and Ranchlands Protection Program.
- Forest Legacy Program.
- EQIP, WRP, CRP, CREP, and WHIP.
- Million Acre Initiative.

Type(s) of GHG Reductions

- **CO_2:** Conservation of agricultural lands retains the ability of the land to sequester carbon in soil and biomass. Also, emissions are indirectly reduced to the extent that development patterns are influenced and vehicle miles traveled (VMT) are reduced (see TLU Option 1a).
- **CH_4 and N_2O:** Are also indirectly reduced as VMT are reduced.

Estimated GHG Reductions and Costs (or Cost Savings)

- **GHG reduction potential in 2010, 2020 ($MMtCO_2e$):** 0.2, 0.3.
- **Net Cost per $MtCO_2e$:** $114.

  Note: The reductions and cost per Mt estimated for this option only refer to the direct benefits and costs associated with the estimated loss of soil carbon from agricultural soils due to development. They do not include the indirect benefits of more efficient development patterns that could result from this option (see TLU Option 1a).

- **Data Sources:**

  The annual rate of agricultural land conversion in NC is 100,000 acres per year based on the footnoted reference above. This is very close to another estimate of 101,600 acres/yr taken from a 2001 study.[39] The typical level of soil carbon in agricultural soils in NC was taken from a 2002 study of Piedmont soils (0.017 MMtC/1,000 acres for the top eight inches of soil).[40] The cost of establishing conservation easements on agricultural lands surrounding developing areas was taken from NRCS information on the Farm

[39] 1992-1997 rate of conversion from - Commission on Smart Growth, *Growth Management and Development: Findings and Recommendations*, Fall 2001, at www.eatsmartmovemorenc.com/resources/documents/aces/aces_smartgrowth.pdf.

[40] Franzluebbers, A.J., B. Grose, L.L. Hendrix, P.K. Wilkerson, B.G. Brock, "Surface-Soil Properties in Response to Silage Intensity under No-Tillage Management in the Piedmont of North Carolina," presented at the 25th Southern Conservation Tillage Conference for Sustainable Agriculture, Auburn, AL, June 24-26, 2002, at www.ars.usda.gov/SP2UserFiles/Place/66120900/SoilManagementAndCarbonSequestration/2002ajfP02.pdf. The data associated with high intensity crop tillage were used to develop the value used in this analysis.

Preservation Program (FPP).[41] The FPP program provides cost share to establish conservation easements on agricultural lands (up to 50% cost share). As the available data were taken from a 2001 summary for NC, CCS used the high end of the range of costs per acre to represent potential costs in 2007 dollars ($2,069/acre). This cost is nearly identical to the nationwide average determined by the American Farmland Trust ($2,000/acre).[42]

- **Quantification Methods:**

GHG Benefits

Studies are lacking on the changes in below and above-ground carbon stocks when agricultural land is converted to developed uses. For some land use changes, carbon stocks could be higher in the developed use relative to the agricultural use (e.g., parks). In other instances, carbon stocks are likely to be lower (graded and paved surfaces). CCS assumed that the agricultural land would be developed into typical tract-style suburban development. It was further assumed that 50% of the land would be graded and covered with roads, driveways, parking lots, and building pads. The final assumption was that 75% of the soil carbon in the top eight inches of soil for these graded and covered surfaces would be lost and not replaced. CCS assumed no change in the levels of above-ground carbon stocks.

The benefit in each year was determined by: (1) determining the amount of land protected in each year by multiplying the annual rate of agricultural land lost by the percent of agricultural land protected; (2) multiplying the soil carbon content on the protected land by 50% (representing graded and covered areas) and by 75% (fraction of soil carbon lost); (3) converting the soil carbon lost to CO_2 by multiplying by 44/12. Table H-7 provides a summary of the estimates for each year.

[41] NRCS, 2001. Range of Farmland Protection Program costs for easements, range $1,660 - $2,059/acre, average $1,885/acre; Farmland Protection Program, NC Summary, December 2001, at www.nrcs.usda.gov/programs/frpp/StateFacts/NC_2001.pdf.

[42] American Farmland Trust, A National View of Agricultural Easement Programs, at http://www.aftresearch.org/PDRdatabase/NAPidx.htm.

Table H-7. Land Protection Schedule and Associated Benefits

Year	% of Conversion Reduced	Ag Acres Protected	$MMtCO_2e$ Saved
2007	0	0	0.00
2008	10	10,160	0.07
2009	10	10,160	0.07
2010	20	20,320	0.13
2011	20	20,320	0.13
2012	30	30,480	0.19
2013	30	30,480	0.19
2014	30	30,480	0.19
2015	30	30,480	0.19
2016	40	40,640	0.26
2017	40	40,640	0.26
2018	40	40,640	0.26
2019	50	50,800	0.32
2020	50	50,800	0.32
	Totals	**406,400**	**2.6**

Costs

To estimate program costs in each year, CCS used multiplied the estimated agricultural acres protected from development by the conservation cost ($2,069/acre) and an assumed cost share of 50%. This cost share is assumed to be available from the NRCS or other sources (e.g., city or county governments, or non-government organizations). The resulting cost effectiveness is $114/Mt. This estimate only accounts for the direct reductions associated with soil carbon losses estimated above and does not include potentially much larger indirect benefits associated with reductions in vehicle miles traveled (see TLU Option 1a).

Note that the availability of this cost share is a significant assumption for this policy option, since the number of acres to be protected is substantially higher than the average protected during the 1996-2001 period (about 200 acres/year). Without the cost share, the cost effectiveness would be twice the value presented here.

- **Key Assumptions:** No change in above-ground carbon stocks; 75% loss of soil carbon on 50% of developed land; 50% cost share available from NRCS, city/local governments, or other sources.

Key Uncertainties

As described above, these include the estimated above and below ground carbon stocks for agricultural and developed land uses and the availability of cost share programs to offset the costs of purchasing conservation easements.

Additional Benefits and Costs

- **Human and Social Issues:** Protection of working lands will provide a better quality of life for the citizens of North Carolina and protect its rural Landscapes and heritage. Protection of these lands will also help to preserve lands for producing food, fuel and other resources needed by society.
- **Environmental Issues**: (1) Working lands provide environmental services to the citizens of North Carolina by providing clean air, clean water, and wildlife habitat that all North Carolinians enjoy. It has been well documented that impervious surfaces and development has a detrimental affect on our natural resources. (2) The Preservation of working lands can also suppress suburban sprawl and help decrease transportation related emissions.
- **Economic Issues:** (1) Cost of community service studies show that residential development does not pay for itself in taxes. However, working lands require an average of .34 cents in services for every $1 collected from local governments. This is a net gain for local and county budgets (AFT). (2) Agriculture is the #1 industry in North Carolina at $68 billion dollars in total revenue.

Feasibility Issues

None noted.

Status of Group Approval

Complete

Level of Group Support

Unanimous

Barriers to Consensus

None

AFW-4b. Preservation of Working Lands – Forest Land

Mitigation Option Description

Reduce conversion of forest lands to non-forest cover such as development and to reduce the rate at which forested tracts are becoming parcelized and/or fragmented. Developed areas contain lower amounts of biomass and its associated carbon. These areas also sequester less carbon dioxide than forested areas. When landowners don't have the incentive to retain their ownership, they often not only sell for development, but they may sell a forested tract by smaller parcels which may then be too small to allow forest management to be practical. On tracts too small and fragmented to be managed, the goals of AFW 9&10 cannot be achieved. Managed stands sequester carbon faster than non-managed stands. Also, harvested products from managed stands sequester carbon long-term in durable products. Finally, biomass used for energy purposes can offset fossil fuel use.

Mitigation Option Design

North Carolina is losing on average 61,390 acres of productive forest each year over the last 30 years to development and a lack of post-harvest regeneration. This amounts to a loss of about 10% of the state's forestland since 1974, or about a 0.36% annually compounded loss.

- **Goals:** Reduce the rate of conversion by 10% by 2010 and 25% by 2020.
- **Timing:** See above.
- **Parties Involved:** NC Division of Forest Resources, NC Extension, NCSU College of Natural Resources, NC Forestry Association, and NC Woodlands.
- **Other:** The conversion of forested lands to developed uses is not consistent; between 1984 and 1990, there was actually an increase in the timberland area of 260,000 acres. This offers hope that one might reverse the overall trends in forest losses.

Implementation Mechanisms

- Use valuation, perhaps subsidize where use value is same as commercial value.
- Higher value to forestry, see AFW 9 & 10.
- Better funding for existing forest conservation easement programs
- Retain Forestry Present Use Valuation

Related Policies/Programs in Place

- North Carolina Conservation Tax Credit Program
- North Carolina Forest Legacy Program

Type(s) of GHG Reductions

- Prevention of emissions from forest conversions and retention of soil carbon
- Continued forest growth and sequestration on protected acres

- Carbon sequestration in the form of durable wood products and fossil fuel offsets from forest based energy (not quantified)

Estimated GHG Reductions and Costs (or Cost Savings)

- **GHG reduction potential in 2010, 2020 ($MMtCO_2e$):** 1.7, 4.3.
- **Cumulative GHG reduction potential ($MMtCO_2e$, 2007-2010):** 35.5
- **Net Cost per $MtCO_2e$:** $3
- **Data Sources:** US Forest Service Methods for Calculating Forest Ecosystem and Harvested Carbon with Standards Estimates for Forest Types of the US, General Technical Report NE-343 (also published as part of the Department of Energy Voluntary GHG Reporting Program). Data from the USFS Forest Inventory Program were used to determine the average annual rate of forest loss over the last 30 years. North Carolina Conservation Tax Credit Program (http://www.enr.state.nc.us/conservationtaxcredit/pages/creditperformance.html). North Carolina Forest Legacy Program – internal Forest Legacy documents provided by Dr. Mark Megalos and (http://www.dfr.state.nc.us/tending/tending_legacyoverview.htm).
- **Quantification Methods:** Carbon savings were estimated as the portion of carbon that would be lost as a result of forest conversion to developed uses. A carbon savings coefficient was calculated from standard carbon stock coefficients for a 65-yr old loblolly-shortleaf pine stand in the southeastern US (Table H-8). It was assumed that 95% of the carbon stocks would be lost in the event of forest conversion to developed uses with no appreciable carbon sequestration in soils or biomass following development.

Table H-8. Carbon Stocks for 65-year-old Loblolly-Shortleaf Pine in the Southeastern US

Forest Carbon Pool	MtC/acre	MtC/ha
Live tree	40.3	99.6
Standing dead tree	1.2	2.9
Understory	1.2	2.9
Down dead wood	3.3	8.1
Forest floor	5.8	14.4
Soils	28.2	69.6
Total	**79.9**	**197.5**

Source; USFS GTE NE-343, Table B39

Carbon savings were calculated using a gradual phase in of the goal levels. A 2.5% reduction in annual forest conversion rates was assumed in 2007 (i.e., conversion did not occur on 1,535 acres of forests as a result of the program). The number of acres that were not converted to developed uses was increased incrementally by 2.5% per year until 2010, at which point 6,139 acres of forest were maintained instead of being converted to development. From 2010 to 2020, the number of acres of forest not converted each year phases in more gradually (i.e., by 1.5% each year), such that by 2020, 15,348 acres of forest is maintained instead of converted. Each year, the number of acres estimated to

remain in forest as a result of the program was multiplied by 95% of the total carbon stock shown in Table H-8.

Annual carbon savings over the time period 2007-2020 are shown in Figure H-1 and cumulative carbon savings are shown in Figure H-2.

Figure H-1. Annual Carbon Savings

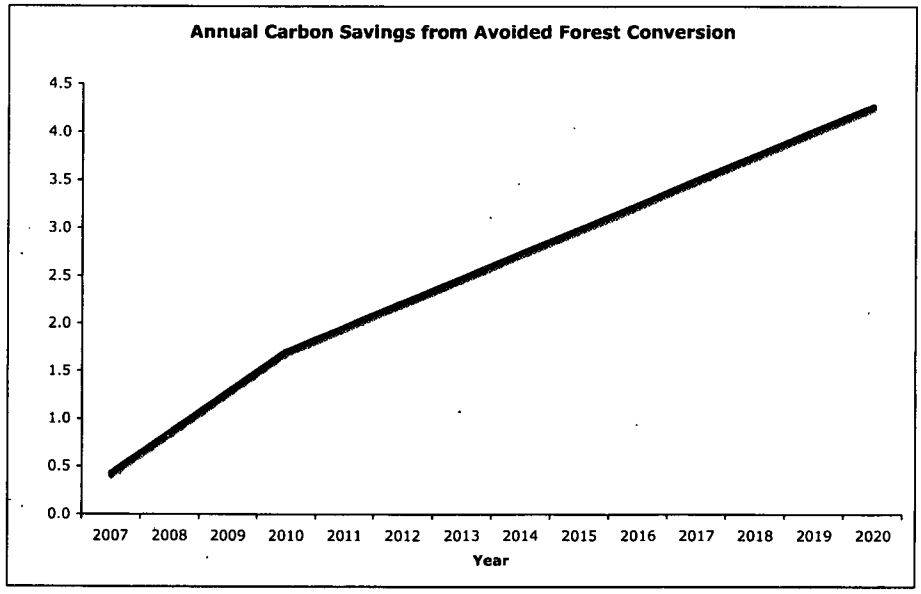
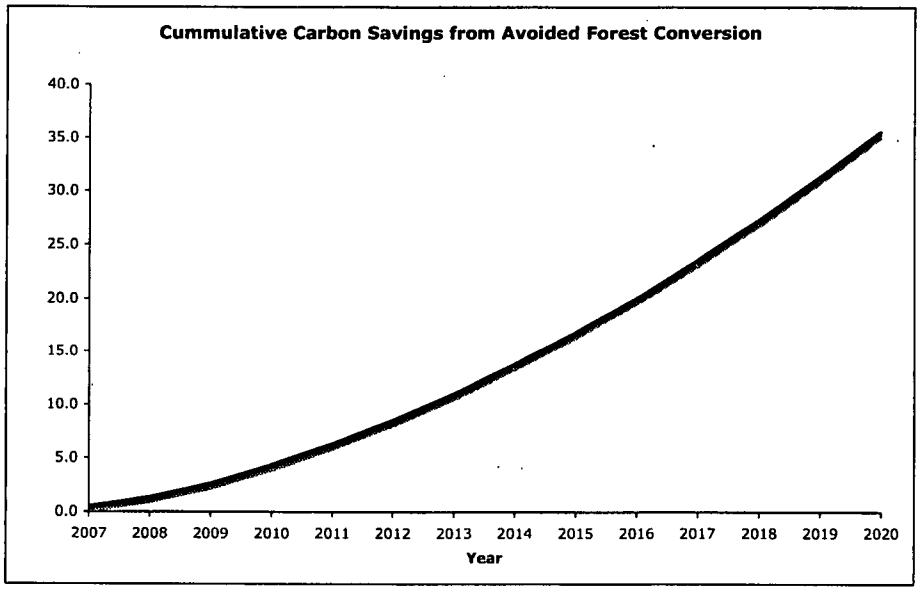


Figure H-2. Cumulative Carbon Savings



The typical cost of conservation easements in North Carolina was used as a basis for the per acre cost of preventing forest conversion. The number of forest acres not converted each year as a result of the program was multiplied by $1,300/acre to get total annual costs each year from 2007-2020. In 2007, annual costs were $1,995,175, rising each year

to a total of $19, 951,750 in 2020. Annual discounted costs were estimated using a 5% interest rate. The cumulative cost effectiveness of the total program was calculated by summing the annual discounted costs and dividing by cumulative carbon sequestration, yielding $3/t$CO_2$e.

- **Key Assumptions:** The analysis assumes that 95% of total forest carbon is lost when forests are converted to developed uses and that no appreciable carbon sequestration occurs post-development. This is based on expert judgment of the TWG that nearly complete removal of biomass and topsoil occurs when land is developed in NC. The analysis does not account for carbon sequestration in harvested wood products, which may enhance carbon savings if forests falling under this option are managed for harvest. For the purposes of the analysis it was assumed that forests are primarily pine types and coefficients for loblolly-shortleaf stands were used.

  The analysis assumes a cost of $1,300/acre, based on data from the NC Forest Legacy Program and the NC Conservation Tax Credit Program. The Forest Legacy Program reports costs of $1,304 - 1,573/ac for the period 2000 to 2005 for 6,500 acres of land conserved. The North Carolina Conservation Tax Credit Program reports an average cost to the state in tax credits of $1,318/acre for 1999 to 2005 for 14,500 acres of land conserved. The cost of $1,300/acre, which is at the low end of the range for the NC Forest Legacy Program was chosen with the rationale that product-oriented forest management on some portion of the lands would add value that could not be explicitly factored into the analysis.

Key Uncertainties

- Whether the amount of land in this analysis would be developed during the period covered, in the absence of this option. A map of lands in the North Carolina Conservation Tax Credit Program (http://www.enr.state.nc.us/conservationtaxcredit/images/ctcp2004.gif) shows lands that are at some risk of development (primarily located in the coastal, Triangle and Triad areas of NC).
- The full range of factors that limit current development easement programs. Funding is a primary limiting factor. Program design is also an issue, for example, lack of term easements (35-50 years) and in some cases the inflexible nature of some easement agreements with regard to forest management/harvesting can limit their application.
- The future value of land prices. They could increase to the point of that these programs will not be cost effective. Easement values will always be less than the total value of the land.

Additional Benefits and Costs

Non-quantified benefits include an improved or maintained quality of life for people near conserved lands as well as wildlife, recreation and watershed improvements.

Feasibility Issues

Better funding of programs to purchase development easements for continued and improved forest management is needed to assure successful implementation of this policy.

Status of Group Approval

Complete

Level of Group Support

Unanimous

Barriers to Consensus

None

AFW-5. Agricultural Biomass Feedstocks for Electricity or Steam Production

Mitigation Option Description

Offset fossil fuel use with agricultural biomass as feedstock for electricity, steam, or heat generation. Agricultural biomass includes, but is not limited to, poultry litter, livestock manure, and crop residues, as well as energy crops (e.g., switchgrass, hybrid poplar). Offsetting fossil fuels use reduces the GHG emissions associated with these fuels.

Note: This option links with AFW-1, which promotes the use of anaerobic digesters and energy utilization. It explores additional opportunities for agricultural biomass energy use. This option also has linkages to ES Options 1 (Renewable Energy Incentives), 2 (Environmental Portfolio Standard), and 10 (NC Greenpower Renewable Resources Program), and to RCI Option 10 (Distributed Renewable and Clean Fossil Fuel Power Generation).

Mitigation Option Design

- **Goals:** Increase agricultural biomass use for electricity, steam, and heat generation to utilize 10% of available biomass by 2010, 25% of available biomass by 2020, and 50% of available biomass by 2030. Voluntary, incentive-based programs should be used to foster development of the industry and associated economic markets.
- **Timing:** See above.
- **Parties Involved:** NCDA&CS, NCSU, NCA&T, Cooperative Extension, NC State Energy Office, DAQ, Utilities Commission, Electric Utilities, Livestock & Poultry Producers, and Crop Producers.
- **Other:** Explore biomass utilization for electricity, steam, and heat generation using 100% biomass and/or co-firing with other feedstocks (as described in the ES and RCI options cited above).

Implementation Mechanisms

- To build a biomass fuel collection and distribution infrastructure, incentives will be needed in the form of tax breaks (sales and/or income) for incurred capital costs for biomass processing and transportation equipment.
- Inclusion/Expansion of voluntary programs such as NC Green Power or other energy production-specific cost share programs.
- Increased research to improve return on investment.
- Education for potential producers of power purchase agreements and interconnection with the grid.
- Public education of benefits of electricity produced from biomass, drive demand.
- Additional research for utilization of available biomass for electricity production.

- Additional research for more efficient biomass processing and delivery for utilization in electricity or heat/steam production.

Related Policies/Programs in Place

- NC Renewable Energy Property tax credit. State income tax credit for 35% of construction costs not to exceed $2.5M or 50% of tax burden.
- Federal Renewable Electricity Production Tax Credit.
- NC Green Power.

Type(s) of GHG Reductions

- **CO_2:** Savings occur as a result of displacing fossil fuel use in the production of electricity or steam.

Estimated GHG Reductions and Costs (or Cost Savings)

- **GHG reduction potential in 2010, 2020 ($MMtCO_2e$):** 0.009, 0.022
- **Net Cost per $MtCO_2e$:** $54.

  Note: The costs and benefits shown above are those associated with in-state biomass feedstock delivery to a power plant or heat/steam end user. The benefit is based on offsetting coal use. The GHG benefits and costs from offsetting fossil-based power or heat/steam generation with biomass generation are covered in the ES and RCI sector. While the costs for purchasing biomass are covered in the ES and RCI sectors, the costs represented here relate to the incentives program needed to develop a biomass collection and distribution infrastructure within the state. Since, the ES-1 and 2 analysis captures fuel lifecycle benefits, the benefits shown above largely overlap with those quantified under the ES options (most of the biomass generated under this option was to be directed to the electricity sector and only a small amount directed to RCI). Accordingly, the benefits shown above, have been removed from the sector totals adjusted for overlap.

- **Data Sources:** Information on available biomass feedstocks was taken from a recent study supporting a renewable portfolio standard in NC.[43] A primary source of information for this study is a 2004 report from the NC Solar Center.[44] Estimates of available agricultural biomass feedstocks are shown in Table H-9.

[43] *Analysis of a Renewable Portfolio Standard for the State of North Carolina,* prepared by La Capra Associates for the NC Utilities Commission, December 2006.

[44] *Use of Agricultural and Forest Waste as a Distributed Generation Power Resource in North Carolina,* NC Solar Center, July 16, 2004.

Table H-9. Estimated Annual Agricultural Biomass Resources

Feedstock	Annual Resource (dry tons)	Annual Resource (MMBtu)
Corn Stover	963,494	14,259,711
Wheat Straw	60,413	942,443
Poultry Litter[45]	50,000	650,000
Switchgrass	263,132	4,210,112
Hybrid Poplar	302,909	5,149,453
Totals	**1,639,948**	**25,211,719**

NOTE: Dairy and beef cattle and hog manure could be an additional biomass resource for this option, but were left out of this analysis to avoid overlap with AFW-1.

- **Quantification Methods:**

GHG Benefits

Since the direct benefits of using biomass energy in place of fossil fuels at the combustion source (e.g. power plant, industrial boiler) are captured in the applicable ES or RCI analysis, the benefits assessment here focused on the incremental GHG benefits associated with fuel delivery. The analysis assumes that biomass will replace coal.

National average emission factors for coal mining/processing and transport were taken from Argonne National Laboratory's GREET model.[46] The sum of these emission factors is 0.0044 $MtCO_2e$/MMBtu of coal delivered. To estimate the emissions associated with delivering biomass in NC, an emission factor of 0.0009 $MtCO_2e$/MMBtu was developed.[47]

The GHG benefit was estimated as the difference between the emissions from coal delivery and biomass delivery. Emissions for each were based on the amount of fuel to be delivered in each year determined from the goals of the policy (2.5×10^6 MMBtu in 2010 and 6.3×10^6 MMBtu in 2020).

Costs

Implementation of this option notes the need for building biomass collection and distribution infrastructure in the state. To address this need, CCS assumes that a five-year incentives program will be needed. The cost of these incentives was estimated as the difference in the

[45] The estimate for poultry litter assumes a broiler population of 100,000,000 in NC and heat content of 6,500 Btu/lb dry solids ("Animal and Poultry Waste-To-Energy", L. Bull, NCSU, at: www.cals.ncsu.edu/waste_mgt/waste%20to%20energy.pdf and litter production of one ton per thousand birds, at www.fibrowattusa.com/US-Press/WattPoultryUSA%20Dec%2001%20on%20Nutrient%20Mgt.pdf. Moisture content of litter is assumed to be 50%. Additional litter produced in turkey or hen/breeder operations not included.

[46] Michael Wang and Ye Wu, Argonne National Laboratory, personal communication with S. Roe, CCS, February 23, 2007.

[47] This emission factor is based on the following data and assumptions: diesel emission factor 10.04 $MtCO_2e$/gal; 23 ton diesel truck fuel consumption - 6 miles/gallon; round trip delivery of 100 miles; biomass has a moisture content of 30%; average heat content of dry biomass is 7,687 Btu/lb.

cost of delivered coal versus the cost of delivered biomass from agricultural residues as estimated by the US DOE ($1.27/MMBtu).[48] The five year program assumes that sufficient demand will be put in place through the ES and RCI renewables options after five years, such that additional incentives for collection and distribution infrastructure are not needed.

- **Key Assumptions:** National average coal emission factors for mining/processing and transport are representative of the coal consumed in NC; the emission factor developed for NC biomass delivery does not include emissions for equipment used for on-site collection/processing of biomass due to a lack of information (the high end of the range of transport radius, 50-miles, was selected to compensate for this lack of data); the cost difference between coal and delivered biomass (national data) are representative for NC and provide a sound basis for the size of the incentives program needed to build collection and transportation infrastructure in the state. All biomass is utilized by the RCI or ES options.

Key Uncertainties

See key assumptions above. Of these assumptions, those associated with the cost and length of the incentives program are the most uncertain. It is also assumed that all of the biomass resource is utilized by the ES or RCI sectors (and the fossil fuel offset benefit remains with those sectors).

Additional Benefits and Costs

- Additional markets for agricultural biomass.
- Economic growth from electricity produced from local feedstocks, rural economy benefits.

Feasibility Issues

- Demand from electric utilities and the RCI sector.

Status of Group Approval

Complete

Level of Group Support

Unanimous

Barriers to Consensus

None

[48] Biomass price differential between agricultural residues and coal from EIA in NEMS biomass supply modeling; $2.50/MMBtu for biomass compared to $1.23 for coal; $2.50/MMBtu represents the price where significant resource potential becomes available; www.eia.doe.gov/oiaf/analysispaper/biomass/table3.html.

AFW-6. Policies to Promote Ethanol Production

Mitigation Option Description

Offset fossil fuel use (gasoline) with production and use of starch-based and cellulosic ethanol. Offsetting gasoline use with ethanol can reduce GHGs to the extent that the ethanol is produced with lower GHG content. Provide incentives for the production of ethanol from crops, forest sources, animal waste, and municipal solid waste.

Note: This option is linked to the TLU biofuels option (TLU-7). That option focuses on mechanisms to increase biofuels consumption in North Carolina. The quantification of benefits and costs for each option takes into account the anticipated GHG reductions to be achieved by each.

Mitigation Option Design

- **Goals:** Several projects are being proposed that would result in the production of 150 million gallons of ethanol annually in North Carolina by 2008. Incentives could increase this amount to a volume equivalent to offsetting gasoline consumption in the state by 10% in 2015 and 25% by 2025. These goals are based on cellulosic ethanol being commercially viable by 2015.
- **Timing:** See above.
- **Parties Involved:** NCDA&CS, Department of Administration, Motor Carrier Enforcement Division, DENR, Department of Commerce, NC Rural Center, NCSU, NCA&T, other state agencies, agricultural associations which represent producers of feedstock, petroleum industry trade groups, and various industry and forestry associations.
- **Other:** Identify incentives that encourage the growing of feedstocks, production of ethanol in North Carolina, and the utilization of ethanol all across the state.
  - Consider impact of expected increases in transportation costs on delivery of feedstocks to processing facilities, and how this effects optimal distribution of production infrastructure.

Implementation Mechanisms

- Incentives in the form of tax breaks (sales and/or income) for incurred capital costs.
- Streamlined permitting of production facilities. Technical assistance for new producers.
- Active solicitation of new producers.
- Expanded consumer education to drive demand.
- Expanded producer education to develop skilled workforce.

- Expanded research for cellulosic ethanol production, including energy-specific crops. Additional research needed to verify that sufficient cellulosic feedstocks are available to sustainably achieve the long-term (post-2020) production goals of this policy option.

Related Policies/Programs in Place

- NC Renewable Energy Property tax credit. State income tax credit for 35% of construction costs not to exceed $2.5M or 50% of tax burden.
- Federal Ethanol Mixture Tax Credit, currently $0.50/gallon.

Type(s) of GHG Reductions

- **CO_2:** Lifecycle emissions are reduced to the extent that ethanol is produced with lower embedded fossil-based carbon than conventional (fossil) gasoline. Feedstocks used for producing ethanol can be made from crops or other biomass, which contain carbon sequestered during photosynthesis (i.e., biogenic or short-term carbon). There are two different methods for producing ethanol based on two different feedstocks. Starch-based ethanol is derived from corn or other starch/sugar crops. Cellulosic ethanol is made from the cellulose contained in a wide variety of biomass feedstocks, including agricultural residue (e.g., corn stover), forestry waste, purpose-grown crops (e.g., switchgrass), and municipal solid waste. Local production of ethanol also decreases the embedded CO_2e of ethanol compared to importation from the current U.S. primary ethanol producing regions. Current research indicates cellulose-based ethanol production provides up to 72-85% reduction in GHGs compared to gasoline, whereas an 18-29% reduction is measured from starch-based ethanol production compared to gasoline.

Estimated GHG Reductions and Costs (or Cost Savings)

- **GHG reduction potential in 2010, 2020 ($MMtCO_2e$):** 0.9, 6.9.
- **Net Cost per $MtCO_2e$:** $5.
- **Data Sources:** In-state production targets were estimated based on the current and projected levels of gasoline consumption (from the GHG Inventory & Forecast), the policy design parameters, and information on BAU ethanol production.[49] The total BAU production (194 MMgal/yr) is based on information gathered from a variety of sources for proposed ethanol plants in NC. The first step in estimating in-state production targets is shown in Table H-10. The estimated in-state production volumes are the volumes needed in each year to show progress toward the 2015 and 2025 policy goals minus the estimated BAU production:

[49] BAU production assumes first phase of Agri-Ethanol Plant in operation - 57 MMgal/yr in 2007; second phase in 2008 - 57 MMgal; E85 Inc. and Clean Burn Fuels also have proposed plants (capacities unknown) - assume another 80 MMgal/yr BAU production in 2008. Total BAU production is 194 MMgal/yr. This value is assumed to remain constant through 2020.

Table H-10. Estimating In-State Ethanol Production Needs

Parameter	2010 (MMgal)	2020 (MMgal)
BAU Gasoline Consumption	5,076	5,764
Ethanol Needed for Policy Targets	193	896
BAU Ethanol Production	194	194
Ethanol Production Needed	0	702
[a] Based on 3.8% gasoline offset by 2010 and 17.5% by 2020 (toward 2025 goal of 25%).		

Since the BAU production meets the levels of production needed for 2010, a different ramp up schedule was set up for incentives in the early part of the policy period (2007-2014) to stimulate production using GHG-superior methods (cellulosic ethanol, starch-based ethanol using renewable energy). The overall production schedule is shown in Table H-11.

Table H-11. Assumed ethanol production schedule (MMgal/yr)

Assumed Ethanol Production Schedule (MMgal/yr)			
2007	–	**2017**	584
2008	10	**2018**	686
2009	60	**2019**	790
2010	110	**2020**	896
2011	160	**2021**	1,026
2012	210	**2022**	1,142
2013	260	**2023**	1,262
2014	310	**2024**	1,384
2015	362	**2025**	1,509
2016	484		

The methods used to estimate GHG reductions and the costs for the policy are provided below.

- **Quantification Methods:**

  GHG Reductions

  The benefits for this option are dependent on developing in-state production capacity that achieves benefits above the levels of existing and planned (BAU) starch-based production in the U.S. (the benefits of using ethanol from starch-based production are already accounted for under TLU-7). Emission factors for reformulated gasoline, starch-based ethanol, and cellulosic ethanol were taken from a General Motors/Argonne National Lab study.[50] These emission factors incorporate the GHG emissions during the entire life cycle of fuel production (e.g., for gasoline: extraction, transport, refining,

[50] *Well-to-Wheels Analysis of Advanced Fuel/Vehicle Systems—A North American Study of Energy Use, Greenhouse Gas Emissions, and Criteria Pollutant Emissions,* General Motors, Argonne National Lab, and Air Improvement Resource, Inc., May 2005.

distribution, and consumption; for ethanol: crop production, feedstock transport, processing, distribution, and consumption). These life-cycle emission factors are referred to as "well-to-wheels" emission factors (see Table H-12 below).

Table H-12. Well-to-Wheels Emission Factors

Fuel	Emission Factor (grams CO_2e/mi)
Reformulated gasoline	552
Starch-based ethanol	451
Cellulosic ethanol	154

In addition to cellulosic ethanol production, the other types of ethanol production processes targeted by this option include starch-based processes that achieve similar levels of life-cycle GHG reductions to cellulosic ethanol. These would be starch-based plants that use renewable fuels, such as biomass, biogas, landfill gas, or other renewable fuels. While CCS is not aware of any lifecycle emission factors for these types of plants (although several have been proposed in the U.S.), CCS assumes that reductions similar to cellulosic ethanol can be achieved.

Based on the emission factors shown above, the incremental benefit of the production targeted by this policy over conventional starch-based ethanol is 66% (reduction of CO_2e by offsetting gasoline consumption). This value was used along with the lifecycle emission factor for gasoline[51] and the production in each year to estimate GHG reductions.

Costs

Costs for the incentives needed by this policy option are based on the difference in estimated production costs between conventional starch-based ethanol and cellulosic ethanol. The DOE EIA estimated that the cost to produce starch-based ethanol is $1.10/gal compared to $1.29/gal, or a difference of $0.19/gal (in $1998).[52] In 2006 dollars, the difference is $0.23/gal. These incentives are considered necessary in the near term (up to 2015) to help commercialize technologies that produce ethanol from cellulose or produce starch-based ethanol using renewable fuels. The incentives should also help to establish the infrastructure to deliver biomass to biorefineries, since producers will seek the local feedstocks or renewable fuels for their operations.

By 2015, it is assumed that advances in cellulosic ethanol production (e.g., enzyme costs, production processes) will make cellulosic ethanol production cost competitive with starch-based production. Hence, the incentives are discontinued beginning in 2015. Note that there is currently federal legislative proposal to offer cellulose an incentive of $0.765/gallon compared to the $0.51/gallon currently offered for ethanol production.[53] If

[51] In the study mentioned above, the average fuel economy used was 21.3 miles/gallon or 100 miles/4.7 gallons. Multiplying this value by the emission factor of 552 grams/mile yields 11,745 grams/gallon.

[52] DOE EIA analysis can be found at www.eia.doe.gov/oiaf/analysispaper/biomass.html, accessed January 2007.

[53] D. Morris, *Making Cellulosic Ethanol Happen: Good and Not So Good Public Policy*, Institute for Local Self-Reliance, January 2007, at www.newrules.org/agri/cellulosicethanol.pdf, accessed January 2007.

enacted, this $0.255/gallon premium could cover the additional incentives that are assumed to be needed by the State of North Carolina. Obviously, the federal incentives do not assure that production facilities would locate in NC. These federal incentives have not been factored into the cost estimates for this option.

The costs for this option were estimated using the $0.23/gal incentive multiplied by the production needed in each year. By 2015, it is assumed that these incentives will no longer be needed as cellulosic ethanol technologies become fully commercialized. Table H-13 contains the assumed schedule for these incentives.

Table H-13. Projected Ethanol Capacity, Incentives Cost, and GHG Benefit: 2007–2020

Year	New Capacity (MMgal)	Incentives Cost (MM 2006$)	GHG Benefit ($MMtCO_2e$)
2007	–	$0.00	0
2008	10	$2.3	0.08
2009	60	$13.8	0.46
2010	110	$25.3	0.85
2011	160	$36.8	1.24
2012	210	$48.3	1.62
2013	260	$59.8	2.01
2014	310	$71.3	2.40
2015	362	$0.0	2.80
2016	484	$0.0	3.74
2017	584	$0.0	4.52
2018	686	$0.0	5.30
2019	790	$0.0	6.11
2020	896	$0.0	6.93

After discounting and leveling the costs from 2007–2020, the cost effectiveness is just under $5/$MtCO_2e$.

- **Key Assumptions:** Starch-based ethanol production using renewable fuels achieves equivalent GHG lifecycle benefits as cellulosic ethanol; cellulosic production or starch-based production with renewable fuels can achieve the production levels in the near term (2014 production of 310 MMgal/yr) required by this policy option; Federal tax incentives do not preclude the need for the additional state incentives assumed for the cost estimate.

Key Uncertainties

These include the assumption that commercial-scale cellulosic ethanol production is viable by 2015. Also, that sufficient biomass feedstocks are available in the state to achieve the levels of production proposed in this policy option (see Feasibility Issues below). Finally, that the level of incentives proposed for this option is sufficient to drive the creation of a sustainable biomass

ethanol production industry in the state (both in terms of feedstock delivery and production facilities).

Additional Benefits and Costs

- Additional markets for starch/sugar crops and possibly dedicated energy crops.
- Economic growth from locally produced fuels.

Feasibility Issues

- Feedstock supply for corn based ethanol production. It is not clear whether additional production beyond that needed to supply the current and planned facilities can be achieved without negatively affecting food and feed crop production.
- Feedstock supply for cellulosic ethanol production: Assuming that all of the new production would come from cellulosic technology, Table H-14 provides estimates of the amount of biomass feedstock needed in each year. These estimates were derived using biomass conversion factors that range from 70 gallons ethanol/ton biomass thru 2011 to 100 gallons/ton by 2020.[54]

Table H-14. Projected Ethanol Capacity and Feedstock Needs: 2007–2025

Year	Ethanol Capacity Needed (MMgal)	Cellulosic Feedstock Needed (tons dry biomass)
2007	–	–
2008	10	142,857
2009	60	857,143
2010	110	1,571,429
2011	160	2,285,714
2012	210	2,333,333
2013	260	2,888,889
2014	310	3,444,444
2015	362	4,020,419
2016	484	5,378,883
2017	584	6,487,503
2018	686	7,619,897
2019	790	8,776,457
2020	896	8,961,825
2021	1,026	10,256,697
2022	1,142	11,422,706
2023	1,262	12,616,196

[54] Source: John Ashworth, National Renewable Energy Laboratory, personal communication with S. Roe, CCS, April 2007. Values used were 70 gallons/ton thru 2011; 90 gallons/ton 2012-2019; and 100 gallons/ton 2020-2025.

Year	Ethanol Capacity Needed (MMgal)	Cellulosic Feedstock Needed (tons dry biomass)
2024	1,384	13,837,169
2025	1,509	15,085,624

Forestry Options 9&10 yield 0.3 and 2.1 MMtons of biomass in 2010 and 2020, respectively. In addition to these biomass resources, two other studies[55] found that there was a potential for 6.4 to 12.0 MMtons of biomass resources in the state (the agricultural biomass resources from AFW-5 are captured in these studies as are purpose-grown energy crops, switchgrass and hybrid poplar, and urban wood waste). Based on these estimates, the resource begins to be fully utilized in the 2018 to 2025 timeframe. More detailed studies of NC biomass resource potential will be needed to verify the availability of feedstocks to achieve the levels of production envisioned by the policy option.

Status of Group Approval

Complete

Level of Group Support

Unanimous

Barriers to Consensus

None

[55] 6.4 MMtons estimated in the following report: National Renewable Energy Laboratory, *A Geographic Perspective on the Current Biomass Resource Availability in the United States,* Technical Report NREL/TP-560-39181, December 2005. 12 MMtons estimated in the following report: *Analysis of a Renewable Portfolio Standard for the State of North Carolina,* La Capra Associates, December 2006.

AFW-8. Afforestation and/or Restoration of Nonforested Lands

Mitigation Option Description

Afforest nonforested lands or restore degraded habitats to forests in order to sequester and store carbon above pre-existing conditions. Existing afforestation programs are underfunded for the task of this afforestation, typically there is a long wait list for landowner forestation projects. This option covers the provision of additional incentives to increase the rate of afforestation and restoration.

Mitigation Option Design

- **Goals:** Initiate afforestation/restoration projects on 540,000 acres by 2020.
- **Timing:** By Fall 2007 planting season have candidate acreage identified (by county) in cooperation with NRCS, FSA and NC SWCD and NC DFR.[56] By 2010, achieve afforestation projects on 40,000 acres. Achieve a total of 540,000 acres of afforestation projects by 2020.
- **Parties Involved:** Seek to establish a unified cooperative alliance of farm (NC Farm Bureau), forest landowner (NC Woodlands, North Carolina Forestry Association), agencies (NC DFR, NC DA), utilities (Duke, Progress Energy), and industrial and non-governmental organizations to promote and implement the coordination needed to reach this historic goal.
- **Other:** Afforestation, the planting of trees on lands that have not recently supported forests, has both carbon sequestration and other environmental benefits—storing over one ton of carbon per acre each year (on-site, not including off-site storage and offsets in products). Afforestation delivers other important benefits such as improved wildlife habitat, reduced soil erosion and fertilizer runoff, and new recreational opportunities. There is a large opportunity for afforestation on agricultural, brownfields, and other lands in NC (possibly greater than 1.5 million acres).[57] These lands are relatively productive for forestry, as the croplands have typically been previously fertilized with mineral nutrients. The average cost-sharing for forestation success in the NC Forest Development Program (FDP) averages between $90 and $200 per acre.[58] The FDP has been the major funding mechanism for state assistance to landowners foresting their lands (~90% of all acres cost shared by currently active NCDFR administered forestation programs[59]) and has reached

[56] Natural Resources Conservation Service & Farm Services Agency (USDA), North Carolina Soil and Water Conservation Districts and Division of Forest Resources.

[57] Conservation Compliance: the Clock is Running. Cook, M. and D. Hoag. 1997 SoilFacts, AG-439-23, at http://www.soil.ncsu.edu/publications/Soilfacts/AG-439-23/. Accessed 10/3/2006.

[58] Forest Development Program, Annual Accomplishment Summary, 2006, Joann Hocut, NC Division of Forest Resources.

[59] Ibid.

approximately 85% of NIPF landowners doing forestation over the last 6 years (1999-2005).[60]

Implementation Mechanisms

An Afforestation Task Force comprised of the Parties Involved would advise North Carolina Division of Forest Resources regarding an enhanced Forest Development Program, which will additionally target agricultural lands. The cost share rates would be 100% of establishment costs (only seedlings, planting, and herbicide the first year) plus $200 of rent payments over 5 years which would be expected from a CRP type program. The overall cost to the state per acre of afforestation is about $340. Program and salary costs for 3 foresters to implement this program would be about $200,000 annually.

Bioenergy markets can increase demand for energy plantations, and potentially influence afforestation/reforestation rates in NC.

Related Policies/Programs in Place

Federal Conservation Reserve Program
Federal Conservation Reserve Enhancement Program
North Carolina Agriculture Cost Sharing Program
North Carolina Forest Development Program

Type(s) of GHG Reductions

- Carbon sequestration from new forest growth
- Sequestration in durable wood products and fossil fuel offsets from forest based energy (not quantified, outside of analysis period)
- Prevention of emissions from forest conversions and improved retention of soil carbon over agriculture (included in AFW 7)

Estimated GHG Reductions and Costs (or Cost Savings)

- **GHG reduction potential in 2010, 2020 ($MMtCO_2e$):** 0.2, 2.4
- **Cumulative GHG reduction potential ($MMtCO_2e$, 2007-2010):** 15
- **Net Cost per $MtCO_2e$:** $9
- **Data Sources:** US Forest Service Methods for Calculating Forest Ecosystem and Harvested Carbon with Standards Estimates for Forest Types of the US, General Technical Report NE-343 (also published as part of the Department of Energy Voluntary GHG Reporting Program). NC Division of Forest Management, Forest Development Program (Joann Hocutt), cost share rates.
- **Quantification Methods:** The amount of carbon sequestration achieved over time as a result of afforesting 40,000 acres by 2010 and 500,000 acres from 2010 to 2020 was quantified using carbon sequestration coefficients in Table H-15.

[60] Chris Hopkins' synthesis of Forest Statistics for North Carolina, 2002 and FDP reports.

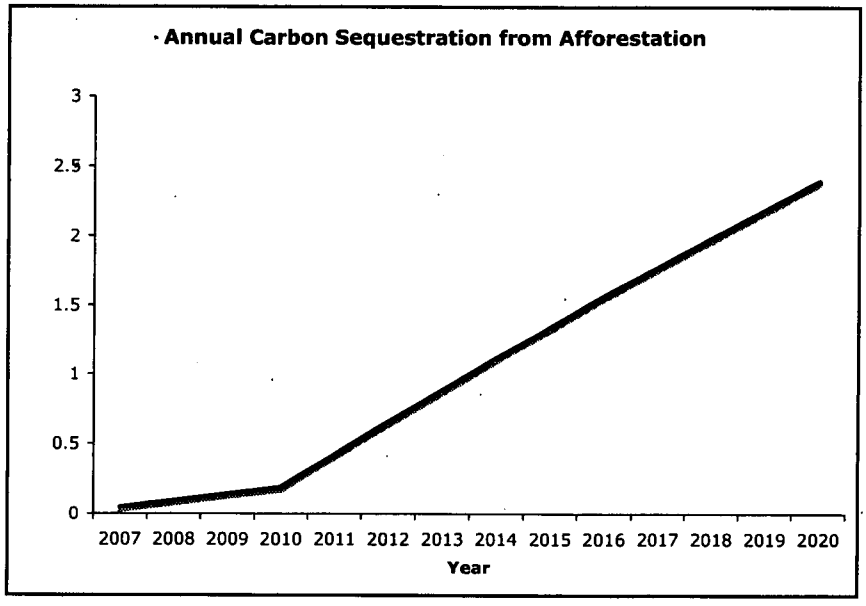
Table H-15. Carbon Sequestration Rates for Loblolly-Shortleaf Pine in the Southeastern US (Tons per Acre and Hectare)

Stand age	tC/acre/yr	tC/ha/yr
0–5	1.28	3.16
5–15	1.12	2.77

Source; USFS GTE NE-343, Table B39

Carbon sequestration was calculated annually, assuming afforestation rates of 10,000 acres/yr (4,045 ha/yr) from 2007-2010 and 50,000 acre/yr (20,225 ha/yr) from 2011-2020. Annual carbon sequestration was calculated separately for stands age 0-5 yrs and 5-15 yrs and summed for an annual total. Annual carbon sequestration as a result of afforestation over the time period 2007-2020, under full implementation of the goals outlined above, are shown in Figure H-3. Figure H-4 shows the cumulative total carbon sequestration over the same time period.

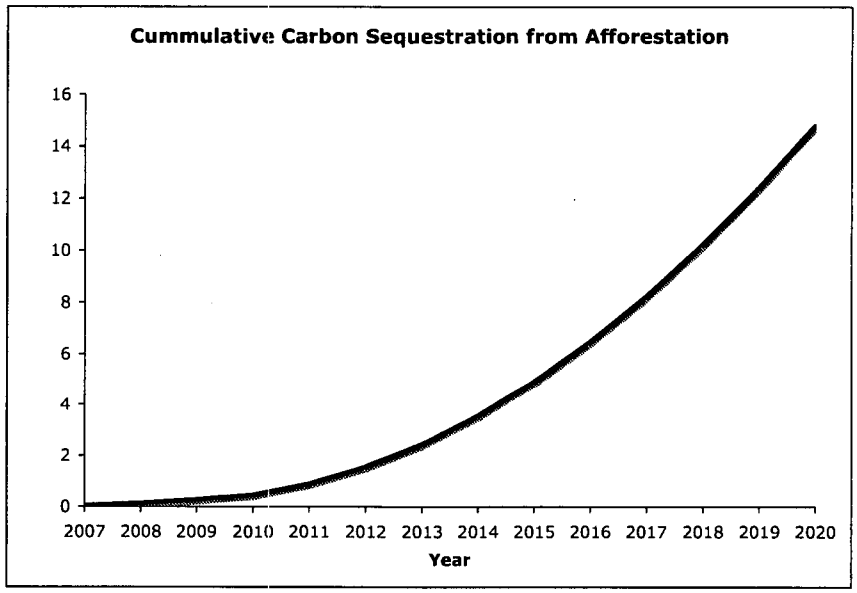
Figure H-3. Annual Carbon Sequestration



The cost of afforestation was estimated as an expense of $340/acre (see key assumptions) multiplied by the number of acres planted each year plus $200,000 per year for other program costs (i.e., forestry staff). Afforestation costs from 2007-2010 were $3,600,000/yr and costs from 2011-2020 were $17,200,000/yr. Annual discounted costs were estimated using a 5% interest rate. The cumulative costs effectiveness of the total program was calculated by summing the annual discounted costs and dividing by cumulative carbon sequestration, yielding $9/MtCO$_2$e.

- **Key Assumptions:** All planted forests were assumed to be primarily pine dominant stands. The cost per acre was assumed at $340/acre based on 100% cost share rates for establishment (seedlings, planting, and herbicide the first year) plus $200 of rent payments over 5 years, which would be expected from a CRP type program. An additional program cost covering salary for 3 foresters to implement this program was assumed at $200,000 annually.

Figure H-4. Cumulative Carbon Sequestration



Key Uncertainties

Whether landowners with unforested land be willing to accept a new form of land management that may be unfamiliar and has a different investment structure than agriculture.

The rent payments of $40 per acre per year for 5 years is shorter than the duration of CRP program payments which are usually 10 years; we believe this will be sufficient for North Carolina, but this is not certain

Additional Benefits and Costs

Non-quantified benefits include an improved or maintained quality of life for people near conserved lands as well as wildlife and watershed improvements.

Feasibility Issues

Better funding of the Forest Development Program to plant forests is feasible given adequate program funding.

Status of Group Approval

Complete

Level of Group Support

Unanimous

Barriers to Consensus

None

AFW-9 & 10. Expanded Use of Forest Biomass and Better Forest Management

Mitigation Option Description

Through proven and accepted forest management practices, increase forest stand productivity and then direct that productivity into the highest-value markets that currently exist. Move the unmarketable logging residue, culls and saplings to the appropriate processing centers for electricity, heating or liquid fuels. Offsetting fossil fuel use reduces GHG emissions. Increase the growth and yield of production from sustainably managed forest resources through site preparation, competition control, thinning, fertilization, and improved genetics. These practices will increase the amount of carbon stored in forested areas and increase carbon dioxide sequestration rates.

Mitigation Option Design

The goal is the expansion of the production and use of wood products for solid wood products, fiber, and fuel. Such use offsets fossil fuel burning in the production of substitute materials (e.g., cement or steel for solid wood products, and plastic for wood fiber). Wood can subsitute for fossil fuels directly in the case of biomass for energy. However these GHG benefits are not explicitly included in the analysis, which focuses on direct carbon sequestration in forests and in wood products. Having a market for relatively low-value biomass products enables forest management for higher-value solid wood products. (See Additional Benefits and Costs section below for more background.)

- **Goals:** Initiate programs to increase forest productivity by 100% on half of NC timberlands by 2020.
- **Timing:** Begin 2007 and increase to full implementation of management programs on 50% of timberlands by 2020
- **Parties Involved:** Division of Forest Resources, NCSU Extension, NC Forestry Association, and NC Woodlands, NCSU, College of Forest Resources
- **Other:** The goal is to double the productivity of timberland for high value products and claim these products and energy as carbon offsets. We estimate that 1.75% (~57 year rotation) of the state timberland (totaling 17.6 million acres) is cut each year, so most timberland is currently under some sort of management, although much of it is of a very low intensity, indeed 25% of harvested stands continue to be high-graded. Our goal is to improve the management and productivity of these lands, especially on the 11.4 million acres held by non-industrial, private-forest landowners.

Implementation Mechanisms

Enhanced funding of the North Carolina Forest Development Program. The full funding level to accomplish program goals would be approximately $230 million annually.[61] This program should include 10% of the budget reserved for forestry extension activities to help educate and

[61] Current program funding levels average $2.6 million per year over the last several years.

motivate forest landowners and professional foresters to better manage their lands and to make the overall program more cost effective.

Improve markets for low value energy wood through the Renewable Environmental Portfolio Standard legislation.

Recognition and ability to trade carbon credits from both standing forests and harvested wood products.

Related Policies/Programs in Place

North Carolina Forest Development Program

Type(s) of GHG Reductions

- Carbon sequestration in forest ecosystems and durable wood products
- Fossil fuel offsets from forest based energy (GHG benefits accounted for elsewhere, i.e., in AFW-6 and in RCI and ES sectors)
- Prevention of emissions from forest conversions and improved retention of soil carbon (not quantified)

Estimated GHG Reductions and Costs (or Cost Savings)

- **GHG reduction potential in 2010, 2020 ($MMtCO_2e$):** 1.5, 5.9.
- **Cumulative GHG reduction potential ($MMtCO_2e$, 2007-2010):** 48
- **Net Cost per $MtCO_2e$:** -$13
- **Data Sources: :** US Forest Service Methods for Calculating Forest Ecosystem and Harvested Carbon with Standards Estimates for Forest Types of the US, General Technical Report NE-343 (also published as part of the Department of Energy Voluntary GHG Reporting Program). US Forest Service Forest Inventory Program. Annual Survey of Manufactures (2005). NC Division of Forest Management, Forest Development Program (Joann Hocut), Forest Statistics for North Carolina 2002.
- **Quantification Methods:** There are two parts to this analysis. The first quantifies the impact of the program on forest carbon (i.e., carbon in living and dead biomass and in soils within the forest ecosystem) and the second quantifies the impact on carbon removed from the forest as durable wood products. The starting point for both parts of the analysis is the same. The Forest Inventory Analysis (FIA) database from the US Forest Service was queried to determine forest productivity (cubic feet of harvested volume) and area of timberlands in North Carolina for the most current year available (2002). Productivity and area data were classified into two categories, pine-dominant forest types and all other forest types (most of which contain oak species) (Table H-16)

Table H-16. Baseline Forest Productivity in North Carolina (FIA, 2002)

Forest Type	Area (acres)	Productivity (cubic feet)	Productivity per area (cubic ft/acre)
Pine (all pine dominant types)	4,960,656	8,483,024,291	1,710
Oak (all other types)	12,716,225	21,841,789,468	1,718

Forest ecosystem carbon sequestration was estimated using average annual carbon sequestration coefficients in Table H-17. Coefficients for pine-dominant stands were based on carbon sequestration rates in Loblolly-shortleaf pine stands in the Southeastern US and coefficients for all other forests were based on carbon sequestration in Oak-hickory forests in the Southeastern US (USFS GTR NE-343). Separate coefficients were available for average and high productivity Loblolly-shortleaf pine stands. Coefficients for improved productivity Oak-hickory stands were not available and thus were estimated by assuming increased rates of carbon sequestration equivalent to 50% of the increases reported for the high productivity Loblolly-shortleaf pine stands.

Table H-17. Forest Ecosystem Carbon Sequestration Coefficients for North Carolina

	Pine (average productivity)	Pine (high productivity)	Oak (average productivity)	Oak (high productivity)*
Stand age		Carbon Stocks (MtC/ac)		
0	40.16	44.41	26.84	27.46
90	90.00	96.56	89.84	91.92
Avg. annual carbon sequestration (tC/ac/yr)	0.55	0.58	0.70	0.71

* USFS does not provide high-productivity carbon values for Oak forest types in the Southeast. These values were calculated by assuming a 2.3% increase in carbon sequestration, which is half the percent increase reported by the USFS for Pine.

Source: USFS GTR NE-343, Tables A39, A40, A44

Baseline annual carbon sequestration was calculated by applying the average productivity coefficients in Table H-17 to the forest areas in Table H-16 each year from 2009-2020. To calculate carbon sequestration under program implementation, the forest areas achieving high and average productivity each year were modeled for the time period of 2009-2020. Under program implementation, forest treatments to improve productivity were assumed to begin in 2007. By 2009, high levels of productivity would be realized on 10% of the targeted area split equally between Pine and Oak classes (total targeted area is 50% of all NC timberland, or 8,838,441 acres). Each year, the area of forests at high productivity levels was increased by 10% until the full goal level was achieved in 2018. Total forest area was held constant each year.

High productivity and average productivity carbon sequestration coefficients were applied to the relevant forest area estimates each year to calculate forest carbon sequestration under program implementation. Baseline levels were subtracted to calculate the incremental increase in carbon sequestration as a result of the program. The results are shown in Table H-18.

Table H-18. Summary of Forest Area and Forest Carbon Sequestration from 2009-2020 (under baseline and program implementation)

Year	High productivity forests (ac)	Average productivity forests (ac)	Carbon sequestration under the program (MMtC/yr)	Baseline carbon sequestration MMtC/yr)	Carbon sequestration above baseline (MMtC/yr)
2009	883,844	16,793,037	11.66	11.65	0.02
2010	1,767,688	15,909,193	11.68	11.65	0.03
2011	2,651,532	15,025,349	11.70	11.65	0.05
2012	3,535,376	14,141,505	11.71	11.65	0.07
2013	4,419,220	13,257,661	11.73	11.65	0.08
2014	5,303,064	12,373,817	11.75	11.65	0.10
2015	6,186,908	11,489,973	11.76	11.65	0.12
2016	7,070,752	10,606,129	11.78	11.65	0.13
2017	7,954,597	9,722,285	11.80	11.65	0.15
2018	8,838,441	8,838,441	11.81	11.65	0.17
2019	8,838,441	8,838,441	11.81	11.65	0.17
2020	8,838,441	8,838,441	11.81	11.65	0.17

Forest sequestration in harvested wood products (HWP) was calculated following guidelines published by the US Forest Service. Details on each step of the analysis can be found in the guidelines, following the methodology referred to as "Land-based estimation." In general, forest productivity is used as a starting point and regional patterns in the disposition of carbon through various HWP pools are used to model carbon stock changes in HWP over time. The methodology calculates the transfer of carbon through four pools over time: wood in use (i.e., building materials, furniture), wood in landfills (i.e., products that were previously in use and have been discarded), wood burned for energy capture, and wood that has decayed or burned without energy capture. The difference in the amount of carbon entering the "in use" and "landfill" pools at the beginning of a year and the amount remaining one year later equals total net annual carbon flux in HWP.

For this analysis, carbon sequestration in HWP was compared under baseline and program implementation levels. Baseline levels of carbon sequestration in HWP were calculated using forest productivity values in Table H-16 and default coefficients for pine and oak forest types and for the southeast region. Two modifications were made to estimate carbon sequestration under program implementation. First, productivity levels were gradually increased as described above for the analysis of forest ecosystem carbon. Second, the disposition pattern was modified such that 10% less wood was disposed in landfills and instead shifted to use for energy production, thus providing more feedstocks for bioenergy. In both cases, the annual area harvested in NC was assumed to be 317,800 acres (Forest Statistics for NC, 2002).

The results of the analysis are summarized in Table H-19, which show the amount of carbon stored in landfills and products in-use each year above what would have happened in the baseline, spanning the time period 2009-2020. While the amount of additional carbon in landfills and in products from a given harvest decreases each year (as it is emitted through decay or energy capture), additional wood is harvested each year and at increasing levels of productivity. Thus for every year in the time series, the carbon stocks in the wood products pool are increasing. This analysis is carried out until 2020 and does not capture the continued disposition of carbon through the wood products pools in time.

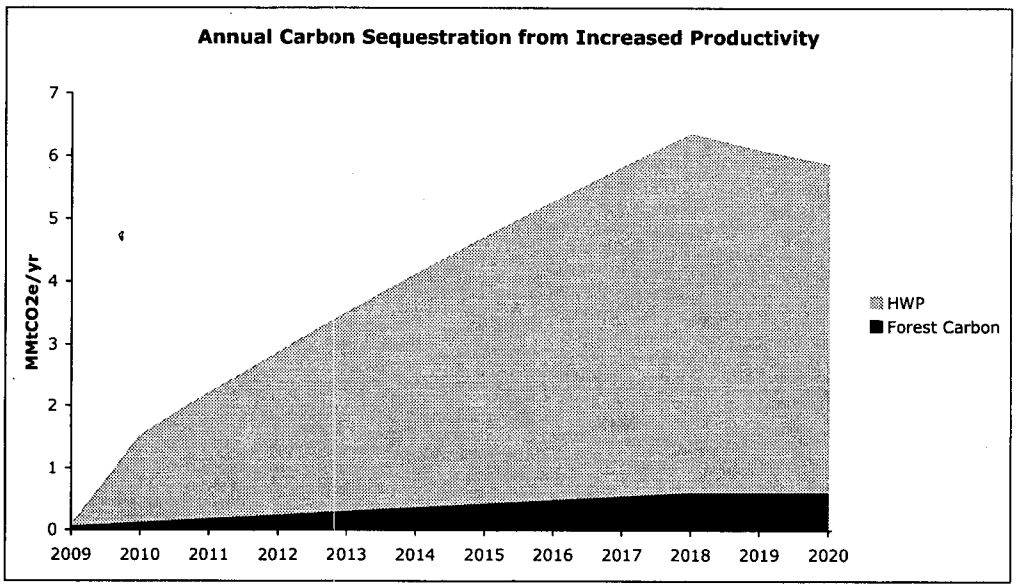
An alternative approach for estimating carbon stored in wood products is to estimate the amount of carbon remaining in products and landfills after 100 years and apply that value to the year of harvest (GTR NE-343, 1605b technical guidelines). This approach accounts for emissions that would occur over 100 years following harvest in the year of the harvest, and assumes that the carbon remaining after 100 years is stored permanently. This approach was developed to simplify annual reporting of carbon stored in wood products and to account for the long term dynamics of carbon flows in harvested wood products pools. For comparison to the analysis covering 2009-2020, the amount of carbon above baseline levels that would be stored in products and landfills 100-yrs after harvest is shown in the last column of Table H-19. The total carbon still stored in HPW from harvests that occurred during 2009-2020, after 100 years is 5.15 MMtC (compared to the cumulative carbon stored in HWP during 2009-2020, of 11.93 MMtC).

Table H-19. Disposition of Carbon Stored in Landfills and in Products over Time (amount is additional carbon above baseline levels)

Year of harvest	Carbon from the harvest in yr x (x=row) that is in use or landfill by the end of year y (y=column) (MMtC)												
	2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**100 yrs later**
2009	0.19	0.18	0.17	0.16	0.16	0.15	0.14	0.14	0.13	0.13	0.12	0.12	0.07
2010		0.39	0.37	0.35	0.33	0.31	0.30	0.29	0.28	0.27	0.26	0.25	0.14
2011			0.58	0.55	0.52	0.49	0.47	0.45	0.43	0.42	0.40	0.38	0.21
2012				0.78	0.73	0.69	0.66	0.63	0.60	0.57	0.55	0.53	0.27
2013					0.97	0.92	0.87	0.82	0.78	0.75	0.72	0.69	0.34
2014						1.17	1.10	1.04	0.99	0.94	0.90	0.86	0.41
2015							1.36	1.28	1.21	1.15	1.10	1.05	0.48
2016								1.56	1.46	1.38	1.31	1.25	0.55
2017									1.75	1.65	1.56	1.48	0.62
2018										1.95	1.83	1.73	0.69
2019											1.95	1.83	0.69
2020												1.95	0.69
Carbon stored in HWP in year y (MMtC)	0.19	0.57	1.12	1.84	2.71	3.73	4.90	6.20	7.64	9.20	10.69	12.13	5.15
Annual Carbon Sequestration (MMtC/yr)	0.00	0.38	0.55	0.71	0.87	1.02	1.17	1.30	1.44	1.56	1.49	1.43	

Figure H-5 shows the combined estimated GHG reductions from forest carbon and HWP.

Figure H-5. Annual Carbon Sequestration



There are also emissions reductions associated with the displacement of fossil fuels by bioenergy generated from the additional biomass feedstocks resulting from forest productivity enhancements. Under this option, an estimated 15 MMt more biomass would be used for bioenergy from harvests during 2009-2020.

The cost of management treatments to increase productivity was estimated at $8.80/ac/yr multiplied by the number of acres treated each year (see Table H-18 for annual area of high productivity forests). Revenue from the additional harvested wood products generated from productivity treatments was also taken into consideration. The value of additional wood products harvested during 2028-2037 as a result of productivity treatments during 2009-2020 was calculated assuming a future value of $389.90/ac (a present value $119.14/ac). If productivity is doubled on a total of 8,842,200 acres of forestland during 2009-2020, this gives a net present value (NPV) of $1.05 billion in wood products. The combined NPV of the above costs and cost savings were summed for a total NPV of -$639 million (cost savings). Annual discounted costs and cost savings were estimated using a 5% interest rate. The total NPV was divided by cumulative carbon sequestration, yielding a cumulative cost effectiveness of -$13.21/$tCO_2e$.

- **Key Assumptions:** Productivity increases were assumed to be distributed equally between pine and oak forest types; cost of productivity treatments were assumed at $8.80 per acre per year over 30 years, based on NC Forest Development Program cost-share rates for a one site preparation and planting, three fertilization treatments, and one pre-commercial timber stand improvement. The added value of revenue generated from increased forest productivity was estimated at $390 per acre. The analysis assumes no change in total forest area over the period of analysis.

Key Uncertainties

The silviculture of doubling forest growth is relatively well understood. The key questions involved are centered on feasibility of addressing all targeted land. Will 50% of forest landowners be willing to intensify their forest management with the full range of stand improvement and fertilization foreseen by this program? This may require new forms and levels of public outreach not previously practiced by forestry institutions.

Success of this mitigation option is heavily dependent on the expansion of markets for forest products including lumber and bio-fuels. Future housing markets are not predictable and it remains to be seen the degree to which wood-based renewable energy will be adopted. Use of wood for electricity production will be dependent on regulation and/or incentives. Technologies for cellulosic ethanol are still under development for commercial scale production. And, the future for all renewables is largely dependent of future fossil fuel prices.

Additional Benefits and Costs

Increased benefits from forest management would increase forestland owner incomes and the probability of retaining land in forest cover.

Feasibility Issues

NCDFR personnel have indicated they can substantially increase implementation of FDP with landowners given increased funding, but a many-fold increase in this program will require a large and unknown administrative and on-the-ground personnel demand. The Forest Development Program may not be funded at levels high enough to fully support this program. Other complimentary mechanisms of support may be necessary.

A standard application of fertilizer on otherwise unmanaged land can increase average productivity about 66% for hardwood and 77% for softwoods. Improved genetics continues to add 5 to 10% in productivity for each improved generation. Improved thinning and competition control can increase high value product growth by 20%. The logging residue that currently is left in the woods is about 15% of total productivity and this too would be increased by fertilization and could be used for biomass energy. While not all improvements are directly multiplicative, it is clear that we can double forest productivity and more than double carbon sequestration by forests in North Carolina. If goal levels were extended into the future, productivity could be doubled on all managed timberlands by 2030.

Status of Group Approval

Complete

Level of Group Support

Unanimous

Barriers to Consensus

None

AFW-11. Landfill Methane and Biogas Energy Programs

Mitigation Option Description

Provide incentives that will result in an increase in the recovery of landfill methane for use as an energy source. Increasing the recovery of landfill methane will reduce emissions of this GHG and will offset the use of fossil fuels for commercial/industrial heat/steam generation or electricity production.

Note: This option has linkages to ES Options 1 (Renewable Energy Incentives), 2 (Environmental Portfolio Standard), and 10 (NC Greenpower Renewable Resources Program), and to RCI Option 10 (Distributed Renewable and Clean Fossil Fuel Power Generation).

Mitigation Option Design

Out of approximately 130 open and closed landfills in the state, only about 15 sites are currently recovering landfill methane for energy use.

- **Goals:** Increase the number of uncontrolled municipal solid waste landfills recovering methane as an energy source, such that 50% of the landfill gas being generated is controlled by 2020. This can be done through development of additional landfill gas to energy (LFGTE) projects. For sites where LFGTE is not feasible, implement flaring controls to achieve the goal.
- **Timing:** By 2010, implement LFGTE at 10 sites not currently using these technologies; by 2020, achieve full implementation of the policy (50% coverage of generated LFG).
- **Parties Involved:** Municipal and county governments, private solid waste management companies, local economic development agencies, NC Department of Environment and Natural Resources, NC Department of Commerce, NC Utilities Commission, non-government organizations, and public interest groups.
- **Other:** No distinction is made between the direct use of landfill methane (e.g., for heat or steam) and the use of methane for electricity generation.

Implementation Mechanisms

- Undertake a GIS-based assessment of landfill gas to energy project potentials focusing on identifying end-users (may have been undertaken by NC Solar Center and State Energy Office). Work with the NC Department of Commerce to use the findings for economic development purposes.
- Establish and expand tax credits for the development of landfill gas to energy projects.
- Develop policies that encourage state agencies to enter into fuel/power purchasing agreements that will result in increased landfill gas to energy projects.
- Research the potential to alleviate burdens associated with the NC Utilities Commission rules regarding the treatment of landfill gas to energy projects as regulated utilities.

- Develop a grant program or other incentives to encourage the installation of gas collection systems at landfills for the purpose of flaring landfill methane.

Related Policies/Programs in Place

- NC State Energy Office, NC DENR, NC Solar Center, US EPA – Landfill Methane Outreach Program.
- US Department of Energy, Renewable Energy Production Incentive; US Internal Revenue Code, Section 45; 15 NCAC 13B Section .1500, Standards for Special Tax Treatment of Recycling, and Resource Recovery Equipment and Facilities.

Type(s) of GHG Reductions

Methane Destruction: Flaring or production of energy from landfill gas results in the destruction of methane.

GHGs Reduced via Fossil Fuel Reductions: Use of landfill gas for generating heat/steam or electricity can offset fossil fuel use (e.g., natural gas, coal), which will reduce emissions of CO_2, CH_4, and N_2O from the combustion of fossil fuels.

Estimated GHG Reductions and Costs (or Cost Savings)

- **GHG potential in 2010, 2020 ($MMtCO_2e$):** 1.1, 2.9
- **Net Cost per $MtCO_2e$:** $1

  Information available from the RCI TWG indicates that Option RCI-10 will consume some landfill gas as part of the renewable energy portfolio. The benefit associated with this consumption of an equivalent amount of natural gas (to be claimed under the RCI option) is 0.002 $MMtCO_2e$ in 2010 and 0.007 $MMtCO_2e$ in 2020. These values were subtracted out as overlap in the Summary Table on page 1 of this appendix.

- **Data Sources:** The NC GHG Inventory & Forecast was used as the source of data on available methane emissions. Cost information from EPA's Landfill Gas Cost Model (LFGcost), version 1.4 was used to estimate costs.[62]
- **Quantification Methods:** *GHG Savings.* GHG savings were estimated by determining the CO_2 equivalent for the available methane to be reduced in 2010 (20%) and 2020 (50%) at uncontrolled landfills in the state.[63]

  Additional GHG reductions are achieved by offsetting fossil fuel that would have been used to create the thermal energy or electricity generated by these landfill gas projects. These reductions are provided as part of the LFG cost output and were added to the

[62] Four different runs of LFG cost were provided by A. Singleton, ERG, to S. Roe CCS, March 2007, based on the scenarios specified in the quantification methods section of this option.

[63] The 20% value in 2010 is assumed based on the goal of implementing projects at 10 of about 100 uncontrolled sites. These first sites are likely to be implemented at the largest (highest producing) sites. Based on emissions modeling conducted by CCS during the development of the Inventory & Forecast, implementing projects at 10 of the largest uncontrolled sites would cover at least 20% of the waste in place at these sites and the potential methane emissions.

reductions associated with methane collection and destruction. The total benefits for each year are shown in Table H-20.

Costs

Costs were estimated by applying EPA's LFGcost-web Model (version 1.4) to three different scenarios. The parameters for these scenarios are shown below. These three scenarios were designed to capture the range of costs likely to be seen in NC to apply LFG capture and utilization projects to both uncontrolled and flared landfills. Data to support these three scenarios

Table H-20. Three Landfill Gas Control Options Modeled

Scenario	1	2	3
Current Controls	None	None	Collection & Flare
Year Landfill Opened	1988	1988	1983
Year Landfill Closed	2010	2010	2017
Annual Waste Acceptance Rate (tons)	38,000	38,000	88,000
Landfill Size (acres)	100	100	200
Technology Employed	Small Engine/ Generator Set	Direct Use (heat or steam)	Engine/ Generator Set
LFGcost Value of Energy Produced	$0.045/kWh	$4.50/MMBtu	$0.045/kWh
Modeled Costs	$2.72	-$0.82	$0.15

The data in Table H-20 show that the direct use option results in a net savings (project revenues greater than costs), while the small and standard engine/generator set options result in net costs. Direct use is typically only cost effective when the landfill is within a short radius to the end user (usually a half mile or less). Hence, the opportunities for direct use are limited. Standard engine/generator set projects (800 kW and greater) are used at projects with moderate to large methane production (48 MM cubic feet/year collected on average). Small engine/generator set projects are applicable at smaller sites.

To develop an overall cost for this policy option, CCS used the following assumptions on the mix of projects that would be implemented to achieve the policy's goals: 17% of methane reduced via standard engine/generator set projects (17% of the EPA Landfill Methane Outreach Program database waste in place is at flared sites, which could be candidates for these projects); 20% of methane is controlled by direct use projects (number of projects assumed to be limited by location of end users); and the remaining 63% is assumed to be controlled by small engine/generator set projects.

Using this blend of LFG energy projects and the LFG cost output data, a blended cost effectiveness estimate of $1.57/MtCO$_2$e was estimated. This cost effectiveness estimate was applied to the emission reductions to be achieved in each year by the policy to estimate costs in each year.

CCS did not include the effects of the Section 45 Tax Credit for production of renewable energy, since this credit may or may not be available to many of the projects that would be installed due to this policy. Inclusion of this tax credit would have a small effect at lowering the costs for the policy. For example, the cost effectiveness for the small

engine/generator set option would decrease from the $2.72/Mt estimate shown above to $2.46/Mt.

Information available from the RCI TWG indicates that Option RCI-10 will consume some landfill gas as part of the renewable energy portfolio. The latest estimates are 40 billion BTUs of LFG in 2010 and 138 billion BTUs in 2020. The benefit associated with the offset of an equivalent amount of natural gas (to be claimed under the RCI option) is 0.002 $MMtCO_2e$ in 2010 and 0.007 $MMtCO_2e$ in 2020. These were subtracted at the bottom of the Summary List of Mitigation Options on page 1 to account for this overlap.

- **Key Assumptions:** For this analysis, available methane means 75% of the methane emitted at uncontrolled landfills, which is the assumed amount that can be captured for energy use. Available methane also includes methane being flared at sites with collection and flaring. In 2010, projects are implemented to capture 20% of the available methane; in 2020 this rises to 50%. For costs, the key assumptions are the value of energy produced: $0.045/kWh for electricity projects and $4.50/MMBtu for direct use projects. Higher values for these energy products could reduce the costs of this option significantly.

Key Uncertainties

See Key Assumptions in the section above.

Additional Benefits and Costs

Additional benefits include reducing landfill gas emissions of volatile organic compounds, including some that are hazardous air pollutants.

Feasibility Issues

The practice of locating landfills in very rural areas often results in a lack of viable local end users. Furthermore, the possible treatment as a regulated utility can also prevent landfill gas to energy projects from being developed.

Status of Group Approval

Complete

Level of Group Support

Unanimous

Barriers to Consensus

None

AFW-12. Increased Recycling Infrastructure and Collection

Mitigation Option Description

Increase the quantity of materials recovered for recycling with specific attention given to materials with the greatest ability to reduce energy consumption during the manufacturing process and to materials that may be used as a fuel source (e.g., clean wood waste). Reducing the quantity of materials being put in landfills reduces future landfill methane emissions potential, while recycling reduces emissions associated with the manufacturing of products from raw materials.

Mitigation Option Design

- **Goals:** Increase per capita recovery in the state 25% by 2020.
- **Timing:** Achieve a 10% increase in per capita recovery by 2010 and a 25% increase in per capita recovery by 2020.
- **Parties Involved:** Municipal and county government, private solid waste and recycling management companies, commercial, industrial and institutional generators, and NC Department of Environment and Natural Resources.
- **Other:** For the purpose of calculating per capita recovery, yard waste (yard trash as defined in G.S. 130A-290) and other vegetative debris are not included. Yard waste is banned from disposal in MSW and C&D landfills and experiences large annual fluctuations in both generation and recovery.

Implementation Mechanisms

Numerous options exist for increasing recovery in the state. These options should be thoroughly researched to determine the effectiveness of the various options.

Expand statewide waste reduction education campaigns to include the GHG mitigation benefits of increased waste reduction.

Research the feasibility and impacts of implementing statewide disposal bans for corrugated cardboard and clean wood waste. Make recommendations based on findings.

Conduct extensive research into increased pre-consumer and post consumer food waste diversion[64] covering at a minimum: infrastructure needs, barriers to increasing infrastructure,

[64] Pre-consumer food waste is the easiest to compost. It is simply the preparatory food refuse and diminished quality bulk, raw material food that is never seen by the consumer. This food waste is generally already separated from the rest of the waste stream generated, thus no change is needed to keep contaminants out of the future compost. Post-consumer food waste is more challenging because of separation issues. It is simply the table scrap food refuse. Often, after the consumer is done with the food, the waste is subject to contaminants and a decision has to be made on how to separate the food from other waste. This can be done by having an extra trash can that is only used for food waste.

incremental cost of food waste diversion and potential climate change benefits of food waste diversion. Make recommendations based on findings.

Provide technical assistance to local governments on operating more effective recycling programs (ongoing).

Lead by example for state agencies.

Legislative actions:

- Require any new host community agreements between a landfill developer and any local government to include provisions for a minimum prescribed level of recycling services within a maximum allowable service area per recycling drop-site.
- In lieu of, or in addition to existing local per capita waste reduction goals; requires local government 10-year solid waste management plans to include an enforceable per capita recovery goal that increases annually until 2020. Enforceability may be achieved by requiring local governments to take specific actions to improve performance if goals are not met. An initial minimum recovery rate would have to be determined.
- Increase funding to the NC Solid Waste Management Trust fund for increased grants to local governments and to private sector for additional infrastructure expansion.

Related Policies/Programs in Place

State Solid Waste Management Trust Fund, NC Division of Pollution Prevention and Environmental Assistance (DPPEA) – Community Waste Reduction and Recycling Grants, Recycling Business Development Grants; Local Government Assistance Team, NC DPPEA; Recycling Business Assistance Center, NC DPPEA.

GS 130A-309.10(f) and (f1) – Materials Banned from Disposal and Incineration.

GS 130A-309.09A – Local Government Solid Waste Responsibilities.

Type(s) of GHG Reductions

Landfill Methane: Reducing the quantity of organic material entering the anaerobic environments found in landfills will result in a decrease in methane gas releases from landfills.

Upstream Energy Use Reductions: Less energy is generally required to manufacture goods from recycled feedstocks than from virgin feedstocks. For example, the addition of recycled glass cullet to the glass making process allows manufacturers to operate furnaces at lower temperatures.

Estimated GHG Reductions and Costs (or Cost Savings)

- **GHG potential in 2010, 2020 ($MMtCO_2e$):** 0.20, 0.49.
- **Net Cost per $MtCO_2e$:** $1.

  EPA's Waste Reduction Model (WARM)[65] was used to estimate the emissions associated with the State's current level of recycling and with the goal of increasing recycling by

65 Version 7, August 2005. From http://www.epa.gov/climatechange//wycd/waste/calculators/Warm_home.html. EPA created the Waste Reduction Model (WARM) to help solid waste planners and organizations track and voluntarily report greenhouse gas emissions reductions from several different waste management practices. WARM

25% per capita. WARM is based on a life-cycle approach, which reflects emissions and avoided emissions upstream and downstream from the point of use. As such, the emission factors provided in WARM provide an account of the net benefit of recycling and source reduction actions to the environment.

- **Data Sources:** WARM input data for both the baseline and policy scenarios were provided by the NC Division of Pollution Prevention and Environmental Assistance.[66] WARM is provided by the EPA and can be accessed along with documentation at the website listed in the footnotes to this option.
- **Quantification Methods:** Two different runs of the WARM model were conducted. The first was done to represent the current levels of recycling in the state and the associated GHG emissions and reductions. The second was done to represent emissions and reductions associated with increasing the current level of recycling by 25% per capita. Table H-21 summarizes the results of both model runs:

Table H-21. Analysis Results Using WARM

WARM Run	Total GHG Emissions ($MtCO_2e$)
Baseline (without existing recycling)	6,379,586
Baseline (with recycling)	4,439,516
25% Recycling Increase Above Baseline	3,952,224
GHG Reductions	**487,292**

The 2020 reductions is determined as the difference in emissions estimated for the baseline (with existing recycling programs) and the emissions estimated for the 25% increase in recycling run. For 2010, the reduction was estimated using a factor of 0.4 multiplied by the 2020 benefit (10/25, since a 10% per capita recovery is the policy goal for 2010).

Table H-22 provides the WARM output for the 25% increase in per capita waste recycling. The following waste types are small quantities in NC and were excluded from modeling in WARM: motor oil, oil filters, antifreeze, lead-acid batteries, textiles, and mixed C&D recovery. Since these waste types were left out, recycling for all of the other commodities was increased by just over 26% to mimic a 25% increase in per capita recovery. All commodities were increased by the same percentage. In reality, one would

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is available both as a Web-based calculator and as a Microsoft Excel spreadsheet. WARM calculates and totals GHG emissions of baseline and alternative waste management practices—source reduction, recycling, combustion, composting, and landfilling. The model calculates emissions in metric tons of carbon equivalent (MtCE), metric tons of carbon dioxide equivalent (MtCO2E), and energy units (million BTU) across a wide range of material types commonly found in municipal solid waste. For explanation of methodology, see the EPA report: *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks* (EPA530-R-02-006), at http://epa.gov/climatechange/wycd/waste/SWMGHGreport.html.

[66] Jim Hickman, NC Division of Pollution Prevention and Environmental Assistance and NC AFW TWG, personal communication and WARM spreadsheets provided to S. Roe, CCS, January 2007.

expect to see a differential increase that would likely result in more fiber recovery by percentage increase. No distinction was made between construction & demolition (C&D) waste and municipal solid waste (MSW). All of the waste was lumped together as mixed MSW. Yard waste was also left out of the modeling. It is banned from disposal in C&D and MSW landfills in NC (it can be mulched, composted or sent to LCID landfills (a.k.a. stump dumps).

Table H-22. WARM Output for the 25% Increase in Recycling Run

Material	Incremental Recycling (Tons)	Incremental GHG Emissions from Recycling ($MtCO_2E$)	Incremental Landfilling (Tons)	Incremental GHG Emissions from Landfilling ($MtCO_2E$)	Total Incremental GHG Emissions ($MtCO_2E$)
Aluminum Cans	1,464	(21,855)	(1,464)	(56)	(21,912)
Steel Cans	1,981	(3,548)	(1,981)	(76)	(3,624)
Copper Wire	0	0	0	0	0
Glass	11,573	(3,238)	(11,573)	(445)	(3,683)
HDPE	1,871	(2,628)	(1,871)	(72)	(2,700)
LDPE	0	0	0	0	0
PET	2,927	(4,548)	(2,927)	(112)	(4,660)
Corrugated Cardboard	28,994	(79,455)	(28,994)	(17,019)	(96,474)
Magazines/third-class mail	819	(2,214)	(819)	185	(2,029)
Newspaper	38,794	(135,448)	(38,794)	31,095	(104,353)
Office Paper	694	(1,722)	(694)	(1,573)	(3,295)
Phonebooks	0	0	0	0	0
Textbooks	0	0	0	0	0
Dimensional Lumber	7,770	(19,058)	(7,770)	3,038	(16,020)
Medium Density Fiberboard	0	0	0	0	0
Food Scraps	NA	NA	0	0	0
Yard Trimmings	NA	NA	0	0	0
Grass	NA	NA	0	0	0
Leaves	NA	NA	0	0	0
Branches	NA	NA	0	0	0
Mixed Paper, Broad	476	(1,508)	(476)	(250)	(1,757)
Mixed Paper, Resid.	10,049	(31,857)	(10,049)	(4,237)	(36,094)
Mixed Paper, Office	0	0	0	0	0
Mixed Metals	25,383	(184,436)	(25,383)	(975)	(185,411)
Mixed Plastics	21	(31)	(21)	(1)	(32)

Material	Incremental Recycling (Tons)	Incremental GHG Emissions from Recycling ($MtCO_2E$)	Incremental Landfilling (Tons)	Incremental GHG Emissions from Landfilling ($MtCO_2E$)	Total Incremental GHG Emissions ($MtCO_2E$)
Mixed Recyclables	1,437	(4,122)	(1,437)	(401)	(4,523)
Mixed Organics	NA	NA	0	0	0
Mixed MSW	NA	NA	0	0	0
Carpet	0	0	0	0	0
Personal Computers	289	(712)	(289)	(11)	(723)
Clay Bricks	NA	NA	0	0	0
Aggregate	0	0	0	0	0
Fly Ash	0	0	0	0	0
Total	134,539	(496,379)	(134,539)	9,088	(487,291)

Columns associated with source reduction, waste combustion, and composting were removed from this WARM output table, since these management practices were not considered in the modeling.

Costs

Information on typical landfill tipping fees, current households served by curbside recycling, households not served by curbside recycling, and the costs for adding curbside recycling services and public education were provided by the NC Office of Pollution Prevention & Environmental Assistance:[67]

- Tons of municipal solid waste diverted by 25% per capita increase: about 134,000;
- Average Landfill tipping fee: $35 ton (conservative estimate, as communities served by transfer stations could pay up to $40/ton);
- Households currently served by curbside recycling: 1,384,653;
- Households not receiving curbside service in towns w/ populations of 5,000 or more: 516,941 (community size is assumed to be the minimum for cost effective recycling services);
- Estimated cost of enhancing education and/or adding more materials to what is already collected in areas receiving curbside recycling: $0.60 per household per year; and
- Estimated cost (based on state averages) for adding curbside collection: $27 per household per year.

The cost for enhancing existing programs is: 1,384,653 households x $0.60 = $830,792/yr.

[67] Jim Hickman, NC Office of Pollution Prevention & Environmental Assistance, personal communication with S. Roe, CCS, January 2007.

The cost of adding programs is: 516,941 households x $27.00 = $4,239,884/yr.

For a total cost of: $5,070,676/yr.

The avoided costs of disposal are: 134,000 households x $35.00 = -$4,690,000/yr.

Resulting in a net cost of $380,676/yr.

From the annual cost above and the estimated GHG reductions estimated with WARM, a discounted and levelized cost effectiveness of $1/Mt$CO_2$e was estimated.

- **Key Assumptions:** Within WARM, the following modeling options were selected: (1) material that is source reduced comes from current mix of recycled/virgin materials, not 100% virgin material; (2) NC landfills recover landfill gas at the national average of recovery; (3) landfill gas that is recovered is used for energy recovery, not flared; (4) landfill gas collection system efficiency is 75%; and (5) default distances for materials delivery to management facility were used (20 miles).

Key Uncertainties

See "Key Assumptions" in the previous section

Additional Benefits and Costs

Reduction in other air and water pollutant emissions associated with product manufacturing and transport.

Feasibility Issues

Some legislative action would be required (see Implementation Mechanisms section). Some infrastructure development might be required.

Status of Group Approval

Complete

Level of Group Support

Unanimous

Barriers to Consensus

None

AFW–13. Urban Forestry Measures

Mitigation Option Description

Urban forest cover protection and management offers a potentially cost effect mechanism to reduce energy use, to store/sequester carbon and mitigate land use change (conversion of forest and agricultural lands to residential sites). Strategic planting of trees to shade houses and AC units can yield energy savings of 15% to 50% on cooling costs.[68] Planting of shade trees can reduce summer heating costs, with only marginal increases in winter heating costs, particularly in mild climates. In addition, depending on local conditions, tree planting can reduce wind-speed and further reduce energy costs. The net direct impacts of tree planting are generally estimated to be positive, taking these factors into account.

Mitigation Option Design

- **Goals:** Increase urban tree cover by planting three additional trees (i.e., three more than planned) on all new construction sites starting in 2008, and by planting three new trees on 25% of existing housing units in 2007 by 2020, with the aim of achieving a 25% reduction in annual heating and cooling costs.
- **Timing:** see above.
- **Parties Involved:** Local government planning agencies, developers, residential and commercial property owners, North Carolina Urban Forest Council, DENR Division of Forest Resources, electricity providers, NC Cooperative Extension Service.
- **Other:** Research on cost savings from urban tree planting indicates that planting three additional trees around a housing unit yields cost savings on the order of $150/yr for the southeast (EPA Cooling our Communities). Annual residential energy expenditures on heating and cooling are estimated at $585/yr per housing unit in NC (NC State Energy Plan 2003). Therefore, planting three additional trees amounts to about a 26% reduction in household heating and cooling costs.

Implementation Mechanisms

- Use incentives to encourage developers to retain trees and green space on new construction sites. (Incentives could include density credits, priority during approval/permitting process, utility credits, etc.). Require developers to retain a minimum of 10% canopy cover and those that retain more than that receives increased credits and priority.
- Promote the creation of proper tree preservation and protection ordinances in communities across the state.

[68] Cooling Our Cities, U.S. Environmental Protection Agency PM-221.

- Provide recognition to communities that increase their canopy cover percent (e.g., with CO_2 credits). Allow municipalities and or homeowners to direct benefits of CO_2 sequestration via trees to their budget or charity of their choice, respectively.
- Install green roofs on state buildings – green roofs reduce urban heat islands by providing shade and the cooling effects of evapotranspiration, absorb air pollution, collect airborne particulates, and store carbon, and insulate a building from extreme temperatures (reducing energy costs).
- Support the use of consulting arborists by developers/contractors in the planning and review process prior to building permit submission.
- Empower to NC Division of Forest Resources to increase seedling availability to Urban Tree planting on public lands. Expand the interaction with community groups and environmental organization
- Enhance existing programs (e.g., Neighborwoods, through the Alliance for Community Trees ACT) to educate and cost-share on encouraging seedlings for urban or residential plantings on private home ownerships
- Increase level of support/education to municipalities in order to ensure proper maintenance and care of increased urban forest.
- Designate an Urban Forestry Extension specialist to NCSU Forestry Extension staff

Related Policies/Programs in Place

North Carolina Urban Forest Council
America the Beautiful Program
The Urban and Community Forestry Grant Program
Trees Across Raleigh
Trees Across Asheboro
Quality Forward

Type(s) of GHG Reductions

- Increased carbon sequestration in urban trees
- Avoided emissions by reduced energy use in heating and cooling
- Improved retention of soil carbon (not quantified)
- Carbon sequestration in the form of durable wood products and fossil fuel offsets from forest based energy (not quantified)

Estimated GHG Savings and Costs per $MTCO_2e$

- **GHG reduction potential in 2010, 2020 ($MMtCO_2e$):** 1.4, 4.3
- **Net Cost per $MtCO_2e$:** -$11
- **Data Sources:** Cooling Our Cities, U.S. Environmental Protection Agency PM-221; "Shade trees reduce building energy use and CO_2 emissions from power plants," H. Akbari, Environmental Pollution, Vol. 116, p. S119-S126 March 2002; US Forest Service Effects of Urban Forests and their Management on Human Health and Environmental

Quality (http://www.fs.fed.us/ne/syracuse/Data/data.htm); US Census Bureau statistics on housing units in NC.

- **Quantification Methods:** GHG reductions were quantified separately for (1) carbon sequestration in trees and (2) decreases in residential energy consumption. Trends in US Census Bureau data on housing stocks in North Carolina from 1939-2005 were used to model the NC housing stock from 2007-2020. Since 1938, there was positive growth in housing stock nearly all years, with growth rates ranging from 0.8%/yr during1980-1989 to 11%/yr during 1995-1998. However, growth in housing stock decreased after 1998 and, on average, was -6.5%/yr during 2000-2005. Growth in annual housing stock from 2007-2020 was calculated by assuming 72,454 new housing units were constructed in 2006 (based on the average number constructed per year from 2000-2005) and a -6.5%/yr growth rate for 2007-2020.

  Under the first goal, three additional trees beyond what would normally be planted around new construction in NC are planted on 100% of new housing units every year from 2007-2020. Carbon sequestration in urban trees was assumed at 6 kg C/tree/yr, which is the average for North Carolina in the USFS assessment of urban forest resources (Nowak et al., 2001). Total annual carbon sequestration was calculated each year, including sequestration in trees planted that year and trees planted prior to that year under the program. The results are shown in Table H-23.

Table H-23. Carbon Sequestration in Trees Planted on New Housing Units, 2007–2020

Year	New Housing Units	Number of trees planted	C sequestered in new trees (kg C)	C sequestered in trees planted since 2007 (kg C)	Total CO_2e sequestered ($MMtCO_2e$)
2007	67,751	203,253	1,219,515.93		0.004
2008	63,353	190,059	1,140,356.40	1,219,515.93	0.009
2009	59,241	177,723	1,066,335.16	2,359,872.32	0.013
2010	55,395	166,186	997,118.69	3,426,207.48	0.016
2011	51,800	155,399	932,395.10	4,423,326.17	0.020
2012	48,437	145,312	871,872.76	5,355,721.27	0.023
2013	45,293	135,880	815,278.96	6,227,594.02	0.026
2014	42,353	127,060	762,358.70	7,042,872.98	0.029
2015	39,604	118,812	712,873.53	7,805,231.68	0.031
2016	37,033	111,100	666,600.46	8,518,105.21	0.034
2017	34,630	103,889	623,331.02	9,184,705.67	0.036
2018	32,382	97,145	582,870.22	9,808,036.69	0.038
2019	30,280	90,839	545,035.75	10,390,906.91	0.040
2020	28,314	84,943	509,657.14	10,935,942.66	0.042

Under the second goal, three additional trees are planted on 25% of the 2007 housing stock over the course of 2007-2020. NC housing stock in 2007 was estimated at

4,080,759 units based on US Census Bureau data. The analysis assumed gradual implementation such that three trees were planted on 72,871 units each year. By 2020, three additional trees were planted on a total of 1,020,190 units (25% of 2007 housing stock). Total annual carbon sequestration in these trees was calculated each year, including sequestration in trees planted that year and trees planted prior to that year under the program. The results are shown in Table H-24.

Table H-24. Carbon Sequestration in Trees Planted on Existing Housing Units, 2007–2020

Year	# Units Planted	Number of trees planted	C sequestered in new trees (kg C)	C sequestered in trees planted since 2007 (kg C)	Total CO_2e sequestered ($MMtCO_2e$)
2007	72,871	218,612	1,311,672		0.005
2008	72,871	218,612	1,311,672	1,311,672	0.010
2009	72,871	218,612	1,311,672	2,623,345	0.014
2010	72,871	218,612	1,311,672	3,935,017	0.019
2011	72,871	218,612	1,311,672	5,246,690	0.024
2012	72,871	218,612	1,311,672	6,558,362	0.029
2013	72,871	218,612	1,311,672	7,870,035	0.034
2014	72,871	218,612	1,311,672	9,181,707	0.038
2015	72,871	218,612	1,311,672	10,493,380	0.043
2016	72,871	218,612	1,311,672	11,805,052	0.048
2017	72,871	218,612	1,311,672	13,116,725	0.053
2018	72,871	218,612	1,311,672	14,428,397	0.058
2019	72,871	218,612	1,311,672	15,740,070	0.063
2020	72,871	218,612	1,311,672	17,051,742	0.067

GHG reductions from avoided use of fossil fuels for heating and cooling were also estimated. Reductions in energy consumption were based on energy cost savings from tree planting. Research on cost savings from urban tree planting indicates that planting three additional trees around a housing unit yields cost savings on the order of $150/yr/household for the southeast (EPA Cooling our Communities). Annual residential energy expenditures on heating and cooling are estimated at $584.60/yr per housing unit in NC (NC State Energy Plan 2003). Therefore, planting three additional trees amounts to about a 26% reduction in household heating and cooling costs. It was assumed that at 26% reduction in costs translated into a 26% reduction in annual electricity and natural gas consumption for residential heating and cooling.

In NC, about 52.9 and 26.7 million BTU's (MMBTU) of electricity and natural gas, respectively, are used for heating and cooling per household (NC State Energy Plan 2003). It was assumed that housing units that planted trees under the program reduced electricity and natural gas consumption by 13.75 and 6.94 MMBTUs per year, respectively. Electricity and natural gas emission factors (0.1578 and 0.0528 tonnes CO_2e/MMBTU, respectively) were calculated from the NC Inventory and Forecast (the electricity emission factor was modified based on additional data from the electricity

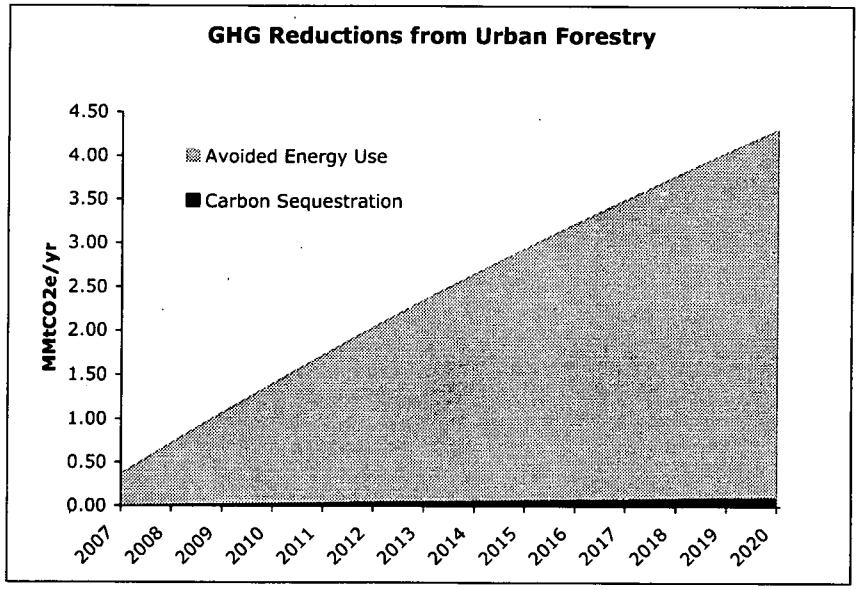
sector in NC, as documented in the ES Methods Memo). The resulting GHG emission reductions are shown in Table H-25.

Table H-25. GHG Reductions from Reduced Use of Fossil Fuels for Household Heating and Cooling

Year	Housing units with additional trees	Energy Reductions-electricity (MMBTU)	Energy Reductions - natural gas (MMBTU)	CO_2e reductions-electricity ($MMtCO_2e$)	CO_2e reductions-natural gas ($MMtCO_2e$)	Total Reductions ($MMtCO_2e$)
2007	140,622	1,934,109	976,195	0.31	0.05	0.36
2008	276,845	3,807,732	1,921,861	0.60	0.10	0.70
2009	408,957	5,624,794	2,838,979	0.89	0.15	1.04
2010	537,223	7,388,967	3,729,403	1.17	0.20	1.36
2011	661,894	9,103,684	4,594,865	1.44	0.24	1.68
2012	783,202	10,772,155	5,436,986	1.70	0.29	1.99
2013	901,366	12,397,382	6,257,280	1.96	0.33	2.29
2014	1,016,590	13,982,172	7,057,164	2.21	0.37	2.58
2015	1,129,064	15,529,150	7,837,964	2.45	0.41	2.86
2016	1,238,968	17,040,771	8,600,918	2.69	0.45	3.14
2017	1,346,469	18,519,328	9,347,185	2.92	0.49	3.42
2018	1,451,721	19,966,970	10,077,847	3.15	0.53	3.68
2019	1,554,871	21,385,701	10,793,917	3.38	0.57	3.95
2020	1,656,056	22,777,399	11,496,343	3.59	0.61	4.20

The relative contribution of tree carbon sequestration and reductions in energy consumption to overall GHG reductions is shown in Figure H-6. Reductions in avoided use of fossil fuels for heating and cooling makes up most of the reductions over the time series.

Figure H-6. GHG Reductions



Urban tree planting has both costs and cost savings. The cost of planting and maintaining urban trees was estimated by multiplying the number of trees planted each year by $250/tree. The cost is based on a reported range of $10-500 per tree (Akbari 2002). The range reflects variation in program implementation and consideration of full life cycle costs (i.e., pruning/maintenance, liability, waste disposal, etc.). The value of $250/tree is near the midpoint of this range. (The reported range does not consider potential uses of biomass waste for energy purposes, neither does this analysis.) In addition, cost savings was estimated by multiplying the cumulative number of households in the program each year by $150/yr/household. Net annuals costs (costs minus cost savings) are initially positive. However, starting in 2011, as more households see cost savings from reduced heating and cooling requirements, costs become increasingly negative. Annual discounted costs were estimated using a 5% interest rate. The cumulative costs effectiveness of the total program was calculated by summing the annual discounted costs and dividing by cumulative carbon sequestration, yielding -$11/ton CO_2e.

- **Key Assumptions:** Future growth of housing stocks is assumed at 6.5%/yr, starting with 4,080,759 existing units in 2007. Three additional trees per household will reduce heating and cooling costs by $150/yr. Costs of planting and maintaining urban trees is $250/tree. Average tree carbon sequestration in urban trees is 6 kg C/tree/yr.

Key Uncertainties

The cost effectiveness of urban tree planting for carbon sequestration is not in doubt. The impact of hurricanes on shade trees is important, but uncertain in timing and spatial distribution. The biggest question is the administration of this program to reduce the cost of planted trees. The ability to implement these programs in smaller and newer communities[69] may be limited by administrative capacity in these communities.

[69] Predominantly in former agricultural lands without trees, although many new communities on former forest land completely clear all original trees.

Additional Benefits and Costs

Additional benefits include an improved or maintained quality of life for people in improved urban forests as well as wildlife, recreation and watershed improvements.

Feasibility Issues

Urban forestry is in general a known field with appreciable positive impacts.

Status of Group Approval

Complete.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

Appendix I
Cross-Cutting Issues
Mitigation Option Recommendations

Summary List of Mitigation Options

	Mitigation Option Name	GHG Reductions ($MMtCO_2e$)			Net Present Value 2007–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of Support*
		2010	2020	Total 2007–2020			
CC-1	GHG Inventories and Forecasts	Not quantified					UC
CC-2	State Greenhouse Gas Reporting	Not quantified					UC
CC-3	State Greenhouse Gas Registry	Not quantified					UC
CC-4	State Climate Public Education and Outreach	Not quantified					UC
CC-5	State Climate Change Adaptation Strategy	Not quantified					UC
CC-6	Options for Goals or Targets (for CAPAG in support of LCGCC)	Not quantified					UC

* UC = unanimous consent (all agree).

CC-1. GHG Inventories and Forecasts

Mitigation Option Description

Greenhouse gas (GHG) emissions inventories and forecasts are essential to understanding the magnitude of all emission sources and sinks (both anthropogenic and natural), the relative contribution of various types of emission sources and sinks to total emissions, and the factors that affect trends over time. The initial use for inventories and forecasts will be to inform state leaders and the public on statewide trends, opportunities for mitigating emissions or enhancing sinks, and verifying GHG reductions associated with implementation of North Carolina's Climate Action Plan. However, it is expected that other uses of the data will be identified as the program evolves. The responsibility for preparing GHG inventories and sinks should reside with the Division of Air Quality (DAQ), which has the expertise needed to systematically compile information on GHG sources and sinks using established methods and data sources. Other state agencies as well as private facilities (sources) will need to provide data to DAQ on a periodic basis. This program should be integrated with existing DAQ inventory and forecast functions as seamlessly as possible. The DAQ, in the September 2005 report under the Clean Smokestacks Act. Committed to an annual completion of a mandatory GHG inventory of point source facilities holding a Title V permit for calendar year 2008. The inventory and forecast will utilize this and other information in an on-going effort to be improved and expanded over time, based on improvements to the accuracy and completeness of data needed to support this effort, usefulness of the data, and experiences gained on these large point sources. The Division has expressed a desire to expand this inventory to a full scale effort as resources, expertise and priorities allow.

Mitigation Option Design

Goals:

- Develop a periodic, consistent, and complete inventory of emission sources and sinks on a continuing basis with forecasts to reasonable and realistic future years (5 and 10 years), to and including 2020 (and eventually beyond).
- Inventory of all natural and man-made emissions generated within the boundaries of the state (i.e., production-based inventory approach) as well as emissions associated with energy imported and consumed in the state (i.e., consumption-based inventory approach).
- Provide a projection of the emissions from the same source categories and on the same basis into the future to produce a realistic forecast of what the emissions will be in future years reflecting expected growth and application of scheduled and implemented mitigation options.
- Provide a basis for documenting reductions and credits "by difference" from year to year.

Timing: The program should be implemented as soon as possible as allowed by funding. Reporting by major (Title V) point sources holding an air permit will begin for calendar year 2008. The process for these and other sources should repeat as often as necessary to track significant reductions or increases, beginning with every year for major point sources and every

third year for other sources to be in agreement with routine EPA air emissions reporting requirements and regulations for other regulated air pollutants.

Parties Involved: All emission sources and sinks (both anthropogenic and natural) should be included.

Other:

- The state has already initiated efforts for collecting 2008 emissions data for point sources subject to a North Carolina Title V air permit.
- The *GHG Inventories and Forecasts Design Characteristics Matrix* provided in Annex A is reference material to, not explicitly part of, this mitigation option.

Implementation Mechanisms

North Carolina currently requires major point sources of criteria air pollutants to report their emissions to the state, and DAQ reviews the emissions for accuracy annually. An unofficial "difference" report should be issued annually for major point sources and include updates as available for other categories that are on an every-third-year rotation. The state would develop inventories and forecasts for area sources, small point sources and mobile emissions. Individual facilities could optionally secure outside certification for any emissions they wish to register for potential sale/credit.

Related Policies/Programs in Place

The DAQ already has a computer system for other air pollutants from these source categories. The major (Title V) facilities already report annually, and the GHG are now in the computer system pollutant tables.

Types(s) of GHG Reductions

Establishing a GHG inventory and forecasting function within state government assists in the tracking, management, and ultimately reduction of GHG emissions. It does not reduce GHG emissions per se. Public disclosure of GHG emissions may encourage sources to reduce emissions.

Estimated GHG Reductions and Costs (or Cost Savings)

This option could be considered an administrative and enabling function of the Climate Action Plan (including enabling any future cap and trade options) and will incur overhead costs but not directly reduce emissions per se except where these data motivate reductions for public relations by individual companies or sources.

Data Sources: Many.

Quantification Methods: Several—will be designed to follow standard, comparative and accepted approaches that allow exchange/sale of emission credits should this become a need in this state.

Key Assumptions: No new significant DAQ resource needs are expected in order to implement this option, at least as it applies to large stationary sources.

Key Uncertainties

- Adequacy of ongoing funding for a statewide GHG inventory and forecasting function.

Additional Benefits and Costs

None cited.

Feasibility Issues

None cited.

Status of Group Approval

Complete.

Level of Group Support

Unanimous consent.

Barriers to Consensus

None.

CC-2. State Greenhouse Gas Reporting

Mitigation Option Description

Greenhouse gas (GHG) reporting reflects the measurement and reporting of GHG emissions at a statewide, sector, or sub-sector level to support tracking and management of emissions. GHG reporting can help sources identify emission reduction opportunities and reduce risks associated with possible future GHG mandates by moving "up the learning curve." Tracking and reporting of GHG emissions would also help in the construction of periodic state GHG inventories. GHG reporting is typically a precursor for sources to participate in GHG reduction programs, opportunities for recognition, a GHG emission reduction registry, and to secure "baseline protection." Further, collaboration with other states in the development of a GHG reporting program could enable North Carolina to influence the development of GHG reporting practices throughout the region and nation and build consistency and reciprocity with other state or regional GHG reporting programs.

Mitigation Option Design

Goals:

- Subject to consistently rigorous quantification, GHG reporting should not be constrained to particular sectors, sources, or approaches, in order to encourage GHG mitigation activities from all quarters.
- GHG reporting should be phased in by sectors as standardized quantification protocols, base data, and tools become available, and as responsible parties become clear. All entities (including the state, municipalities, and other jurisdictions) should be allowed to report GHG emissions associated with their own activities and any programs they may implement to reduce GHG emissions.
- GHG reporting should be applicable on a voluntary basis to all sources (e.g., combustion, processes, vehicles, etc.) but applied with common sense regarding de minimis emissions. GHG reporting may be required by DAQ for some categories of sources through normal state rulemaking procedures.
- The goal should be reporting of GHG emissions on an organization-wide basis within North Carolina, but with greatest possible detail by facility in order to facilitate baseline protection.
- Reporting should occur annually on a calendar-year basis for all six traditional GHGs and other pollutants for which the Intergovernmental Panel on Climate Change (IPCC) develops global warming potentials (GWPs) (e.g., black carbon and ozone).
- GHG emissions reports should be verified through self-certification and NC DENR spot-checks. To qualify for future registry purposes, reports should undergo third-party verification.
- Every effort should be made to maximize consistency with federal, regional, and other states' GHG reporting programs and quantification protocols.

- Reporting of direct emissions[1] should be required; reporting of emissions associated with purchased power and heat[2] should be phased in; and reporting of other indirect emissions[3] should be allowed.
- Reporting of emissions from GHG reduction projects should qualify for reporting, when they are identified as such, and adhere to equally rigorous quantification standards.
- The reporting program should provide for appropriate public transparency of reported emissions.

Timing: A GHG reporting program should be implemented as soon as possible.

Parties Involved: All entities that can verify ownership of GHG emissions.

Other: The *GHG Reporting Design Characteristics Matrix* provided in Annex A is reference material to, not explicitly part of, this mitigation option.

Implementation Mechanisms

North Carolina currently requires major point sources of criteria air pollutants to report their emissions to the state, and DAQ reviews the emissions for accuracy annually. An unofficial "difference" report should be issued annually for major point sources and include updates as available for other categories that are on an every-third-year rotation. The state would develop inventories and forecasts for area sources, small point sources and mobile emissions. Individual facilities could optionally secure outside certification for emissions reports that they may wish to register in a GHG registry.

Related Policies/Programs in Place

- Approximately 2,400 point source facilities/sources in North Carolina report criteria pollutant emissions (about 350 Title V's report annually) in order to comply with various federal and state regulatory programs. Most electric generating units are also required to report CO_2 emissions to the Environmental Protection Agency and the Energy Information Administration (EIA). Some sources may report GHG emissions on a voluntary basis to federal, state, or privately-run programs. Otherwise, there is currently no broad, statewide GHG reporting program in North Carolina.
- The DAQ will be collecting GHG emissions from stationary sources subject to a North Carolina state Title V (about 350 facilities) air permit beginning in calendar year 2008 to fulfill a commitment under the Clean Smokestacks Act.

Types(s) of GHG Reductions

GHG reporting is an enabling mitigation option to encourage management, and ultimately reduction, of GHG emissions. GHG reporting does not reduce GHG emissions per se.

[1] Defined as "Scope 1" emissions in the *GHG Protocol;* see www.ghgprotocol.org

[2] Defined as "Scope 2" emissions in the *GHG Protocol;* see www.ghgprotocol.org

[3] Defined as "Scope 3" emissions in the *GHG Protocol;* see www.ghgprotocol.org

Estimated GHG Reductions and Costs (or Cost Savings)

The reporting of GHGs under this mitigation option would help position sources for participating in an emissions trading program, should one develop in the future, leading to cost savings. Although establishment of a credible reporting program is essential for participating in a trading program, these elements do not reduce GHG emissions themselves.

Key Uncertainties

Uncertainties exist with respect to quantification of some GHG emissions from some sources, but standard quantification protocols are rapidly being developed and accepted widely. There remain significant uncertainties with respect to how various state, regional, and/or federal GHG reporting programs may develop, but the best way to affect these outcomes toward North Carolina's benefit may be engagement in these processes by the state now.

Additional Benefits and Costs

None cited.

Feasibility Issues

None cited.

Status of Group Approval

Complete.

Level of Group Support

Unanimous consent.

Barriers to Consensus

None.

CC-3. State Greenhouse Gas Registry

Mitigation Option Description

A greenhouse gas (GHG) registry enables uniform calculation and recording of GHG emissions reductions in a central repository. Typically, a registry also includes transaction ledger capability in order to support tracking, management, and ownership of emission reductions. Registries can help encourage sources to undertake GHG reduction efforts, enable potential recognition for such actions, provide baseline protection, and support the crediting of GHG mitigation actions. A registry can also provide a mechanism for regional, multi-state, cross-border, and even global cooperation. Subject to appropriately rigorous quantification standards, participation in a GHG registry should not be constrained to particular sectors, sources, or approaches in order to encourage GHG mitigation activities of all types from all quarters. In particular, a GHG registry should be able to incorporate activities associated with all of the options that the CAPAG approves, whether reflective of reductions in emissions of GHGs or increases in biological or geological sequestration of carbon.

Mitigation Option Design

Goals: The TWG recommends that North Carolina actively engage with other states in developing a regional or national GHG registry that will comprehensively meet the state's needs. If developing regional or national multi-state registries do not initially include all of the state's preferred criteria, North Carolina should still join and participate to the greatest extent possible, and work to develop whatever additional registry capacity is necessary to meet the remaining needs of North Carolina sources (e.g., registration of carbon sequestered due to reforestation). Together, these approaches should cover all mitigation options the CAPAG recommends, provide adequate quality verification, and allow project-level reporting. Participation by North Carolina sources should be voluntary, and costs should be borne primarily by participants. Recommendations for key registry design characteristics build off the GHG Reporting mitigation option (CC-2). Key elements important to North Carolina include

- Geographic applicability at least at the statewide level and as broadly (i.e., regionally or nationally) as possible.
- Inclusion of as broad an array of sectors, sources, facilities, and approaches as possible.
- Allowing sources to start as far back chronologically as good data exists, as affirmed by third-party verification, and allowing registration of project-based reductions or "offsets" that are equally rigorously quantified.
- Incorporating adequate safeguards to ensure that reductions aren't double-counted by multiple registry participants, and providing appropriate transparency.
- Striving for maximum consistency with other state, regional, and/or national efforts; greatest flexibility as GHG mitigation approaches evolve; and providing guidance to assist participants.
- Allowing the state and its political subdivisions to be valid participants for registering reductions associated with their programs, direct activities, or efforts, including the

registration of emission reductions associated with the stationary and mobile sources they own, lease, or operate. Similarly, the state and its political subdivisions should also be allowed to participate in emission trading if and when such a program is developed and authorized. Revenues associated with the sale of any emission reduction credits generated by the state or its political subdivisions could be used to support the GHG emission inventory, forecasting, reporting, and registry functions within state government.

Timing: As soon as possible after a GHG reporting program is operating.

Parties Involved: Coverage should include all entities that can verify ownership of GHG emission reductions.

Other: The *GHG Registry Design Characteristics Matrix* provided in Annex A is reference material to, not explicitly part of, this mitigation option.

Implementation Mechanisms

Implementation of this program should probably be led by NC DENR. Costs should be shared by participants benefiting from the registry. State staff and that of any outside registry group/funding may be necessary.

Related Policies/Programs in Place

In May of 2007, the state of North Carolina became a charter member of The Climate Registry (TCR), along with 34 other states plus tribal members and Canadian provinces. Currently, the total membership of the TCR includes 40 U.S. states, two Canadian Provinces, one Mexico state, and three Tribal Authorities. The state is represented on the board of directors in the preparation of the protocols and rules by which the group will be governed. TCR board has expressed a goal to be open for business by the beginning of calendar year 2008. TCR is voluntary; however, it will facilitate states, tribes, or provinces choosing to make reporting mandatory for their sources.

North Carolina companies have also been major participants in the 1605 (b) registry that has been operated by the U.S. Department of Energy for several years and has led the state participation in that registry for a number of years. That effort is also voluntary and will likely continue.

Types(s) of GHG Reductions

Not applicable.

Estimated GHG Reductions and Costs (or Cost Savings)

Not applicable.

Key Uncertainties

There remain significant uncertainties with respect to how various state, regional, and/or federal GHG registry programs may develop. Involvement in early registry implementation—as issues are deliberated among states—will be an advantage to North Carolina in their ultimate outcome.

Additional Benefits and Costs

None cited.

Feasibility Issues

None cited.

Status of Group Approval

Complete.

Level of Group Support

Unanimous consent.

Barriers to Consensus

None.

CC-4. State Climate Public Education and Outreach

Mitigation Option Description

Public education and outreach can support greenhouse gas (GHG) emissions reduction efforts at the macro- or micro-scale in relation to emissions reduction programs, policies, or goals. Public education and outreach is vital to fostering a broad awareness of climate change issues and effects (including co-benefits, such as clean air and public health) among the state's citizens. Such awareness is necessary to engage citizens in actions to reduce GHG emissions. Public education and outreach efforts should integrate with and build upon existing outreach efforts involving climate change and related issues in the state. Ultimately, public education and outreach will be the foundation for the long-term success of all the mitigation actions proposed by the CAPAG as well as those which may evolve in the future.

Mitigation Option Design

Goals: The TWG recommends that the state lead by example in its own education and outreach activities by establishing a pro-active public education and outreach capability to assist in the implementation of CAPAG mitigation options adopted by the Governor.

- Education and outreach activities would target five specific audiences:
  - Policymakers and managers (legislators, regulators, executive branch, agencies, and employees)—because implementation of climate actions hinges on approval by policymakers and implementation by managers;
  - Educators and Students—by integrating climate change into primary and secondary educational curricula, post-secondary degree programs, and professional licensing programs;
  - Community Leaders and Community-Based Organizations (e.g., institutions, municipalities, service clubs, social and affinity groups, and non-governmental organizations)—to recognize leadership, share success stories and role models, and expand climate involvement and participation within civic society;
  - General Public—to increase awareness and engage citizens in climate actions in their personal and professional lives; and
  - Industrial and Economic Sectors—to recognize leadership, share success stories and role models, and expand climate involvement and participation within the business community.

Timing: Public education and outreach efforts should commence as rapidly as possible.

Parties Involved: A statewide public education and outreach effort should probably be overseen largely by NC DENR, but would necessarily involve many other key parties.

Other: The *Education Design Characteristics Matrix* provided in Annex A is reference material to, not explicitly part of, this mitigation option.

Implementation Mechanisms

Public education and outreach. Additional staff and/or funding may be necessary depending on the extent of the public education and outreach effort.

Related Policies/Programs in Place

DENR efforts and standard course study.

Types(s) of GHG Reductions

Not applicable.

Estimated GHG Reductions and Costs (or Cost Savings)

Not applicable.

Key Uncertainties

- Timing and degree of federal and private sector recognition and support through awareness, acknowledgement, and quantification of climate change risk.
- Availability of sustained funding for education and outreach.

Additional Benefits and Costs

- Costs: Office establishment, travel for training programs, program materials.
- Benefits: For example, reduced landfill inputs, improved air/water quality, enhanced business opportunities, and reduced congestion and highway infrastructure costs.

Feasibility Issues

Logistics for coordination between agencies and the public; funding for education and outreach.

Status of Group Approval

Complete.

Level of Group Support

Unanimous consent.

Barriers to Consensus

None.

CC-5. State Climate Change Adaptation Strategy

Mitigation Option Description

Due to the existing buildup in the atmosphere of greenhouse gases (GHGs) that has already occurred, North Carolina will experience some effects of climate change for years to come, even if immediate action is taken to reduce future GHG emissions. Thus, it is essential that the state develop a plan to manage the projected impacts of ongoing climate change while worldwide mitigation efforts to lower atmospheric concentrations are underway.

Mitigation Option Design

While taking action to reduce GHG emissions in North Carolina, the state should develop, adopt, and implement a state Climate Change Adaptation Plan that includes identification of (a) potential short-term, mid-term, and long-term impacts of climate change scenarios likely to affect the state and (b) implementation mechanisms for addressing these impacts. The state should empanel a "Blue Ribbon" Commission on Adaptation to Climate Change to develop a state Climate Change Adaptation Plan within one year of establishment of the Commission. The Commission should involve and coordinate with all appropriate state and local agencies, organizations, and institutions (e.g., universities) to ensure that all potential impacts are identified in the plan. The Commission should also enlist the expertise of all appropriate state and local agencies, organizations, and institutions in developing and implementing measures for mitigating these impacts. As a minimum, the Commission should address the adaptation issues in the plan that the CAPAG has identified in the table that accompanies this mitigation option.

The state Climate Change Adaptation Plan should include at least the following key elements:

- Comprehensive identification of potential short-term, mid-term, and long-term impacts associated with climate change in North Carolina.
- Recommended steps to respond to the identified impacts so as to minimize risk in North Carolina to humans, natural and economic systems, water resources, temperature-sensitive populations and systems, energy systems, transportation systems, communications systems, vital infrastructure and public facilities, and natural lands (such as coastal areas, wetlands, forests, and farmland) and all other identified and affected sectors or areas of concern throughout the state.
- Coordination of response efforts through the appropriate state, local and federal agencies, organizations, or other entities or initiatives.
- Characterization of the potential risks and costs of inaction; characterization of the potential costs, benefits, and co-benefits associated with specific policy and program actions; and establishment of time- and program-based goals.
- Use of cost-benefit analysis to guide and inform the development and implementation of the state Climate Change Adaptation Plan. The analysis should include, but not be limited to, an examination of the benefits and costs of adaptation measures or responses relative to a "status quo" or no-action approach, and the resources needed to implement adaptation measures in

the plan. The results of the benefit-cost analysis should also be used to set priorities for addressing short-term, mid-term, and long-term impacts of climate change on citizens, ecosystems, and the economy of North Carolina.

- Adaptation measures that also mitigate GHG emissions should be given priority in the state Climate Change Adaptation Plan.
- Regular review and update of the Plan on a periodic basis (e.g., every 5–10 years) to expand or refine the Plan as necessary, to improve implementation of the Plan, and to incorporate new information as it becomes available.

The state Legislature should provide funding to support development and on-going revision to the state Climate Change Adaptation Plan including, but not limited to, funds to support the benefit-cost analysis needed to guide and inform the development and implementation of the Plan and to cover expenses incurred by the Commission and Commission members.

Goals: Create a state-sanctioned Blue Ribbon Commission on Adaptation to Climate Change to develop a comprehensive state Climate Change Adaptation Plan identifying opportunities to address adaptation issues and risks and recommending tangible, implementable measures to ameliorate these issues and risks to North Carolina citizens. Conduct benefit-cost analyses to compare the potential costs of a "status quo" approach as opposed to implementing the recommendations proposed in the Climate Change Adaptation Plan. Prioritize recommendations in the adaptation plan based on the certainty and severity of adverse impacts to citizens, ecosystems and local economies. Development of the plan should (a) involve all affected agencies and entities at all levels of government; (b) involve all affected sectors and interests; and (c) provide for periodic review and update concerning adaptation risks, responses, and opportunities in the state.

Timing: The Commission should be established as soon as possible. The development of a state Climate Change Adaptation Plan should be completed within one year of establishing the Commission. Benefit-cost analyses of the potential costs of a "status quo" approach as compared to implementing the Plan's recommendations should be conducted as a component of the plan. Parallel public education and outreach efforts regarding adaptation should commence immediately. "Early-adoption" opportunities should be addressed as rapidly as possible (even before the Commission is established, if possible), and pro-active adaptation initiatives should commence within the next 2–3 years.

Parties Involved: The Blue Ribbon Commission on Adaptation to Climate Change should involve and coordinate with all appropriate state and local agencies, organizations, and institutions (e.g., universities) to ensure that all potential impacts are identified and to ensure the successful development and implementation of the plan.

Other: The *Adaptation Issues Matrix* provided in Annex A is reference material to, not explicitly part of, this mitigation option.

Implementation Mechanisms

- State Climate Change Adaptation Strategy.

- Public education and outreach.
- Development of mitigation recommendations as necessary.
- Establish financial structures and create markets that are likely to thrive under anticipated climate impacts.

Related Policies/Programs in Place

- State and local emergency management response plans are in place that address short-term responses to natural disasters (e.g., violent storms). To the extent possible, measures recommended in the Climate Change Adaptation Plan should assist and complement these existing state and local efforts.
- Efforts are being undertaken by the North Carolina Division of Coastal Management (DCM) to require that all coastal counties address and respond to the impact of sea level rise in land use plans. DCM also requires setbacks from the oceanfront and prohibits hardened structures on the oceanfront. DCM allows hardened structures along estuarine waters and requires a 30-foot setback for all structures except those that are water dependent. Measures for responding to sea level rise proposed in the Climate Change Adaptation Plan should assist and complement these existing efforts.

Types(s) of GHG Reductions

Not applicable.

Estimated GHG Reductions and Costs (or Cost Savings)

Not applicable.

Key Uncertainties

Some impacts of climate change, such as sea level rise and inundation of low-lying coastal lands are certain, but their specific timing and magnitude remains unclear. Other impacts are less certain and may have significant variability.

Additional Benefits and Costs

- Innovative early adaptation responses to climate change impacts can be designed to
  - Help prevent and/or reduce costs associated with future catastrophic events and long-term climate change impacts;
  - Direct future public and private investment more effectively; and
  - Ensure preparedness to help avoid extensive cost implications to state, county, city and federal agencies.
- Early preparedness can raise public awareness and encourage further GHG mitigation efforts, which can drive economic opportunities for alternative fuels, agriculture, forestry, and advanced technologies.

Feasibility Issues

None cited.

Status of Group Approval

Complete.

Level of Group Support

Unanimous consent.

Barriers to Consensus

None.

CC-6. Options for State Greenhouse Gas Goals or Targets (for CAPAG in support of LCGCC)

Mitigation Option Description

Many anticipate that eventually the federal government will legislate some cap on greenhouse gas (GHG) emissions associated with global warming. A number of states are ahead of the federal government in establishing GHG caps. For example, the Northeastern States (including New York) have instituted a regional cap and trade program to reduce power-sector GHG emissions. California has recently signed into law an economy-wide cap.

North Carolina has successfully severed the link between increasing energy consumption and emissions of soot and smog-forming pollution; even as energy consumption increases, sulfur dioxide and nitrogen oxide pollution are being significantly decreased.

Now North Carolina should establish voluntary goals to limit GHG emissions to prepare the state's economy for the likely caps at the national level, and begin to sever the link between increasing energy demand and GHG emissions. Even modest reductions in GHG emissions will help to align North Carolina's environmental and economic interests, and assist the state in addressing its contribution to global warming. The goal would not be mandatory, but simply sets a direction in GHG emissions, just like the NC million acre conservation goal.

Mitigation Option Design

Goals: The voluntary goal should be set to bring emissions back to a baseline, such as year 2000.

Timing: The goal should be set over a long-time horizon of 10–15 years to meet the baseline. It should be expressed as an interim goal on the longer path toward ultimate climate stabilization.

Parties Involved: This would be an overall voluntary goal for the State of North Carolina. There would be no mandates to any specific party. However, all sectors of the state's economy would have the opportunity to contribute toward meeting the state's goal.

Implementation Mechanisms

The adoption of such a goal should first be considered by the NC Legislative Commission on Global Climate Change (LCGCC). If recommended by the LCGCC, such a goal could be established by the General Assembly or by an executive order of the Governor.

Related Policies/Programs in Place

None cited.

Types(s) of GHG Reductions

Include all GHGs and black carbon.

Estimated GHG Reductions and Costs (or Cost Savings)

This mitigation option would be established in conjunction with other options and programs. Thus, it is very difficult to estimate the GHG reduced specifically from this mitigation option. As the goal would be voluntary, the cost per $MMtCO_2e$ is anticipated to be quite small and perhaps may create a positive economic benefit.

Key Uncertainties

- Timing and levels of federal standards to cap GHGs.
- Emission inventory by sector of GHGs. A goal would work best in conjunction with a GHG emission reporting program.
- Availability and cost of new and improved GHG-associated technologies.

Additional Benefits and Costs

The benefits of passing this state goal legislation are fivefold:

- **Addressing Potential Global Warming Impacts**—The direct economic toll of global warming on North Carolina may be enormous and would likely include increasing: crop loss due to drought, episodic water shortages, coastal flooding and erosion, and building cooling costs. A state goal will draw attention to regional warming trends and associated effects and help business and government prepare for the future.
- **Economic Development**—As the state plans its economic development activities, a state carbon reduction goal can help promote expansion and recruitment of renewable energy technologies that are less GHG-intensive. Additionally, these activities will seek to generate jobs in North Carolina to replace the non-native coal and gas sources that currently dominate North Carolina's energy supply.
- **State Leadership**—By establishing a state goal, North Carolina will join the numerous states across the country that are already rising to the challenge of addressing GHG emissions associated with global warming.
- **Business Responsibility**—A state goal will be to provide the motivation and opportunity for companies to examine their options for cost-effective reductions in their GHG emissions. Many companies in North Carolina are already considering the need to reduce carbon dioxide in their long-term planning. A reduction goal will foster the broader business community to consider their ability to also reduce GHG emissions.
- **Preparing for the Emerging Carbon Marketplace**—North Carolina business can potentially sell tens or even hundreds of millions of dollars worth of carbon equivalence credits into the carbon marketplace that national climate legislation will likely eventually generate. A state goal would help companies that could potentially be suppliers of carbon credits in the coming national marketplace prepare to take advantage of these economic opportunities as soon as they arise.

Feasibility Issues

The mitigation option is simple, straightforward and voluntary. The goal can be an expression of commitment by the state of North Carolina to address the challenge of global warming through voluntary reductions in GHG emissions.

Status of Group Approval

Complete.

Level of Group Support

Unanimous consent.

Barriers to Consensus

None.

Annex A to CC Mitigation Option Descriptions

Reference Materials

Cross Cutting Issues Technical Working Group
GHG Inventories and Forecasts Design Characteristics Matrix

Purpose and Goals of Inventories and Forecasts:

Tracking GHG emissions trends
Identifying opportunities and areas for action
Others?

	Design Element	Options	Design Considerations	Preliminary Recommendation
1.	**Responsibility for Preparing Periodic Inventories and Forecasts**	Sole responsibility with NC DENR Department of Air Quality (DAQ) Shared responsibility between DAQ and other state agencies	Purpose is to develop consistent, systematic inventories and forecasts from one year to the next. Subject matter expertise is evolving rapidly.	DAQ has substantial emissions inventory responsibility now, so recommend locating responsibility and authority for this function at DAQ as well. Inventories and forecasts should include all sectors/sources. Responsibility of other agencies to provide DAQ with related data and assistance (e.g., VMT) must be explicit.
2.	**Inventory Frequency**	Annual Other	Inventory reflects historical emissions. Different sized sources currently required to report emissions on different schedules (e.g., major sources annually; minor sources every 5 years). Must be consistent with any NC GHG Reporting Program, and should strive for consistency with other inventory and forecasting programs.	Prepare comprehensive, thorough recalculation every 5 years. Publish inventory update annually based on readily available data (e.g., emissions filings from major sources and periodic filings of minor sources) for calendar year. Starting year: Use CAPAG inventory and forecast for past data and 2005; prepare comprehensive revisions in 2010, 2015, 2020, and so on. Dovetail to the extent possible with existing CSA requirements. DAQ to receive public input and comment before finalizing.

	Design Element	Options	Design Considerations	Preliminary Recommendation
3.	**Forecast Frequency and Periods**	Annual Intervals Other	Forecasts reflect estimates of future emissions. Define future years for which emissions inventory is prepared (e.g., frequency and overall forecast period). Define intervals for future year forecasts (e.g., annual, 5-year intervals relative to a base historical year). Limitations exist on availability of activity data for projecting emissions (e.g., current Energy Information Administration (EIA) projections of fuel consumption only go to 2025). Should strive for consistency with other inventory and forecasting programs.	Prepare comprehensive, thorough recalculation every 5 years, alongside inventory. Publish forecast update annually based on readily available data (e.g., emissions filings from major sources and periodic filings of minor sources) for calendar year. Project as far into the future as reasonably possible (e.g., 5, 10, 15, 20, 25, and 50 years). Dovetail to the extent possible with existing CSA requirements. DAQ to receive public input and comment before finalizing.
4.	**Greenhouse Gases Included**	Six "Kyoto gases" (CO_2, HFCs, CH_4, N_2O, PFCs, SF_6) Black Carbon	Must be consistent with any NC GHG Reporting Program, and should strive for consistency with other inventory and forecasting programs. Broader array promotes inventory building, public information, identification of GHG strategies, and so on.	Include mass emissions of the six "Kyoto gases" and black carbon. Calculate CO_2-equivalence to the extent possible.

	Design Element	Options	Design Considerations	Preliminary Recommendation
5.	**Basis for Calculating and Reporting Emissions**	Production based Consumption based	Production refers to emissions generated by sources in-state (e.g., emissions from power generated in-state whether consumed in-state or exported). Consumption refers to "Production" based emissions plus imports and minus exports, at least for the energy sector.	Recommend calculating emissions on both production and consumption bases to the extent reasonably practicable.
6.	**Emissions Quantification**	Calculation methods & tools Federal 1605(b) program details quantification of black carbon emissions.	Apply current best practice methods (e.g., *GHG Protocol* and calculation tools). Strive for consistency with other reporting and quantification programs. Some "other" or "home grown" approaches may be necessary (e.g., Flashing emissions; IPIECA[1], API's[2] SANGEA™ GHG Emissions Software).	Recommend quantifying emissions on the basis of best available practices, minding the importance of consistency with other programs, and transparently noting any necessary departures or changes.
7.	**Public Access & Reports**	• Internet access and/or Online reports • Paper reports • Both		Recommend DAQ make inventories and forecasts readily available to policymakers, interested parties, and the general public via the Internet.

[1] IPIECA is the International Petroleum Industry Environmental Conservation Association.
[2] API is the American Petroleum Association.

	Design Element	Options	Design Considerations	Preliminary Recommendation
8.	**Funding**	• State-funded. • Emission-based fees (would require legislative approval). • Some combination? • Other?	Inventories and forecasts can only be accomplished if adequate DAQ resources exist, so creative funding sources should be investigated (e.g., transaction fees and GHG credit sales).	DAQ should publish the initial annual update based on CAPAG inventory and forecast. Simultaneously, DAQ should consult with interested parties to identify, weigh, and select among creative funding approaches.
9.	**Periodic Reassessment of Inventory and Forecast Approach**	• Authority • Purpose • Frequency	DAQ and involved agencies should have the ability to periodically reassess and revise (if necessary) designs element of the inventory and forecasting program. Sample reassessment considerations: o Relative impact of sources or groups on overall emissions totals vs. costs of calculating their emissions. o Benefits to NC air, taxpayers, businesses?	DAQ should review at 5-year intervals following implementation of the GHG inventory and forecast program. DAQ's review should identify any revisions necessary and appropriate next steps and/or research questions.
10.	**Other?**			

Cross Cutting Issues Technical Working Group
GHG Reporting Design Characteristics Matrix

WRI/WBCSD *GHG Protocol*'s
Principles for GHG accounting and reporting:

1. Relevance
2. Completeness
3. Consistency
4. Transparency
5. Accuracy
6. Enable other goals

Potential Goals of GHG Reporting:

1. Identifying reduction opportunities
2. Reducing risks (e.g., start learning curve)
3. Tracking GHG emissions, assisting the state in constructing annual inventories
4. Participating in voluntary programs
5. Participating in—or preparing for—mandatory programs
6. Precursor for registry participation
7. Opportunities for recognition
8. Public reporting
9. Consistency with other programs
10. Others?

	Design Element	Characteristics	Design Considerations	Preliminary Recommendation
1.	**Type of Program**	Voluntary Mandatory	May need or want to constrain mandatory applicability to certain sectors and/or sources pending availability of accepted quantification protocols. Mandatory reporting is in place in some states for sources subject to a state air permit (e.g., ME, and CT); anticipated soon for several others in Northeast and far West.	
2.	**Sectors**	All sectors eligible Limited to certain sectors	Participation may be limited by availability of quantification methods; may need to "stage" sector participation. WRI calculation protocols: Stationary combustion, mobile, electric power, cement, iron & steel, aluminum, pulp & paper, wood products, lime, ammonia, purchased heat or power, others.	
3.	**Sources**	All Stationary combustion emissions Mobile combustion emissions Process emissions Fugitive emissions	Could limit sources even within sectors, (e.g., via types and size thresholds). Broader array promotes inventory building, public information, identification of GHG strategies, and so on.	• From catalog 2.5: Require mandatory GHG reporting for permitted sources.
4.	**Organizational Boundary**	Entity-wide (e.g., corporation-wide) Facility Emissions unit or source point Other (?)	Clear definitions needed to avoid double counting where shared ownership exists. Should strive to have design be consistent with possible future directions (e.g., mandatory reporting would not be enforceable above the facility level). Combinations are possible (e.g., finer resolution aggregated to a greater whole).	• From catalog 2.2: Report NC emissions from state facilities & vehicles to public & 1605(b).

	Design Element	Characteristics	Design Considerations	Preliminary Recommendation
5.	**Reporting Period**	Annual • Calendar • Fiscal Other	Should strive for consistency with other reporting programs.	
6.	**Greenhouse Gases Included**	Six "Kyoto gases" (CO_2, HFCs, CH_4, N_2O, PFCs, SF_6) Black Carbon Other	Should strive for consistency with other reporting programs. Broader array promotes inventory building, public information, identification of GHG strategies, and so on.	• From catalog 2.3: Include non-CO_2 GHGs.
7.	**Scope of Emissions Covered**	Direct • "Scope 1" Indirect • "Scope 2" - Indirect from purchased Heat & Electricity • "Scope 3" - other indirect (e.g., outsourced activities and employee travel) Both	May need or want to "stage" coverage (e.g., start small & expand). Direct emissions most like current reporting requirements, but may omit GHG reduction opportunities or encourage direct-indirect trade-offs. For many entities, most GHG emissions are from indirect emissions sources.	
8.	**Emissions Quantifi-cation & Monitoring**	Calculation methods & tools Direct measurement (e.g., CEMs, Stack Testing)	Should strive to use current best practice methods, such as *GHG Protocol* calculation tools, and to have consistency with other reporting programs. Some "other" or "home grown" approaches may be necessary (e.g., Flashing emissions; IPIECA[3], API's[4] SANGEA™ GHG Emissions Software).	

[3] IPIECA is the International Petroleum Industry Environmental Conservation Association.
[4] API is the American Petroleum Association.

	Design Element	Characteristics	Design Considerations	Preliminary Recommendation
9.	**Verification**	• State verification • 3rd party verification • Self-certification	If mandatory, the state may be able to use current verification procedures for criteria pollutants. DAQ does 3rd-party verification.	
10.	**Public Access & Reports**	• Internet access and/or Online reports • Paper reports • Both	"Confidential Business Information" (CBI) concerns.	
11.	**Project Level Reporting or "Offsets"**	• Yes/No • Constrain	WRI: Raises quantification, baseline, "additionality," secondary effects, reversibility, and double-counting issues. Location of co-benefits achieved. May be most useful when there is an externally-imposed constraint (e.g., a "Cap").	
12.	**Funding**	• State-funded • Mandated requirement • Emission-based fees (would require legislative approval). • Other? A combination?	Reporting is a necessary cornerstone for a GHG registry, so it may be appropriate to have registry participants share support costs.	
13.	**Others?**			

Cross Cutting Issues Technical Working Group
GHG Registry Design Characteristics Matrix

Notes:

- **Builds upon GHG Reporting Design Characteristics Matrix.**
- **Some Reporting preferences could be outweighed by Registry preferences (e.g., if a regional registry has different specs).**

Potential Goals of GHG Registry:

1. Recording of GHG reductions (vs. emissions)
2. A central, independent repository for credible info about emissions activities
3. A "transaction ledger" – providing data management & accounting critical for trading (with or without a cap)
4. "baseline protection" – enabling early action current or future credit for trading
5. An incentive to track & manage emissions, seek productivity and energy efficiency gains, accelerate learning curve regarding competitiveness & carbon markets
6. Enhance public recognition & demonstrate corporate citizenship
7. Possible vehicle for regional, multi-state & cross-border cooperation
8. Others

	Design Element	Characteristics	Design Considerations	Preliminary Recommendation
1.	**Key Design Criteria (beyond *GHG Reporting Design Characteristics Matrix*)**			
1.1	Define geographical boundaries	• North Carolina • Regional (or broader)	• Span of control. • Cost, economies of scale, & broader = better?	
1.2	Verification	• State verification • Third-party verification	• See GHG Reporting. Design Characteristics Matrix.	
1.3	Base Year	• Single specified year • Single entity-chosen year • Average of multiple years • Adjustment rules?	• Flexibility vs. Simplicity. • Must have good data for Base Year.	
1.4	Project-level submittals	• Yes / No / Constrain	• Against what baseline? • Additionality issues (what would have happened anyway)?	
1.5	"Offsets"	• Yes / Some / No	• Co-benefits location? • Nature / character?	
1.6	Start Date		• Establish a "to be in operation" date?	
1.7	Ownership		• Risk of double-counting.	
1.8	Transparency			
1.9	Others?			

	Design Element	Characteristics	Design Considerations	Preliminary Recommendation
2.	**Technical Issues**			
2.1	Treatment of minority ownership		• GHG Protocol	
2.2	Merger & acquisition issues		• GHG Protocol	
2.3	Quality Assurance; Uncertainty Analysis		• GHG Protocol	
2.4	Regulatory guidance (e.g., protocols and guidance documents)			
2.5	Data flow; filing methods, etc.		• Confidential business information (CBI), legal authority, and so on.	
2.6	Others?			
3.	**Ancillary, Administrative, & Operational Issues**			
3.1	Location (Agency)	• NCDENR • Other?	• Regional potential.	
3.2	Software; Web Interface, etc.	• North Carolina-specific • CCAR, RGGR, CCX, ERT, EATS? • Other?	• Multiple needs (e.g., emissions inventory, allowances, mandatory, or voluntary). • Rapidly changing "state of the art."	
3.3	Cost	• Transaction fee • Publicly supported? • Other?	• Development costs. • Ongoing operating costs.	

	Design Element	Characteristics	Design Considerations	Preliminary Recommendation
3.4	Oversight & Management	• NCDENR • Publicly appointed board • Other?		
3.5	Reporting of Results; Recognition			
3.6	Others?			

Cross Cutting Issues Technical Working Group
Education Design Characteristics Matrix

The recommendations and options in this matrix originate in large part as a result of "Recommendation A-7" in the September 1, 2005 Clean Smokestacks Act report and State Energy Plan (SEP).

Goals of Public Education & Outreach:

1. Overarching goal: Promote awareness among citizens about the impacts of climate change, solutions, and co-benefits of action.
2. Education provides a foundation essential for all climate action.
3. Others?

General Approach:

1. Target the key general audiences and efforts below:
   a. "Walking the Talk" in terms of the state's own efforts and outreach activities;
   b. Policymakers (e.g., legislators, executive, agencies, and regulators);
   c. Future Generations;
   d. Community Leaders and Organizations;
   e. Business and Industry;
   f. The General Public.
2. Ensure long-term sustenance of education and outreach efforts regarding climate change.

	Measures & Strategies	Tasks & Examples	Notes & Elaborations
1.	**State Government Actions** The state should lead by example (i.e., "walk the talk") regarding education and outreach.		
1.1	Create a multi-agency Board (or Office of Climate Change Impacts and Mitigation) to oversee on-going state climate efforts, starting with the implementation of CAPAG mitigation options adopted by the Governor; report progress to the public annually.	• Assemble annual progress reports & make them publicly available.	• Staff the effort adequately; should have one or more "outreach coordinators" specifically tasked with outreach and coordination among agencies and organizations. • Such a Board could also help avoid duplication of efforts in the state.
1.2	Establish an Education & Outreach Subcommittee of the body established in §1.1 to educate audiences regarding CAPAG policies, and to oversee those relating to education.	• Lead implementation of CAPAG education & outreach measures. • First task: Identify already existing resources & programs. • Identify additional needs and potential funding sources.	
1.3	Include state public education and higher education officials in the bodies established in §1.1 & §1.2.	• NC Department of Public Instruction develop teacher training and curriculum.	• A "two-way street": education officials bring research & info to the body; act as outreach arm for reaching students and others. • Post resources online that include hands-on activities such as reducing carbon footprints.

	Measures & Strategies	Tasks & Examples	Notes & Elaborations
1.4	Educate state employees across-the-board, and assign "point persons" to do so on an on-going basis.	• Identify agency liaisons for the multi-agency Board or Office of Climate Change Impacts and Mitigation.	• One possibility: Add climate change outreach as a natural extension to the existing role of Agency Energy Managers.
1.5	Disaggregate the state's GHG emissions to the agency level and require annual agency-specific reports on GHG reduction progress.		• Make agency-specific reports public as part of the report in §1.1.
2.	**Target Audience: Policymakers (legislators, regulators, executive branch, agencies)** Implementation of climate actions hinges on policymakers' understanding and approval.		
2.1	Educate policymakers on climate change & CAPAG policies in order to promote acceptance and implementation.	• Conduct regular legislative briefings. • Identify & offer agency-specific info on climate issues & opportunities.	• Use input derived from policymaker interactions to develop new mitigation measures going forward.
2.2	Provide continuing outreach & assistance to Governor's office, legislature, and implementing agencies on a regular basis.	• Educate press liaisons from agencies and so on • Provide regular press releases or updates on reductions, events, and so on.	
3.	**Target Audience: Future Generations** Integrate climate change into educational curricula, post-secondary degree programs, and professional licensing.		
3.1	Organize groups of educators to identify, assemble, and employ climate change curricula appropriate to age groups.	• Work with the Department of Public Instruction for guidance.	• Check out British Petroleum's www.aplusforenergy.org.

	Measures & Strategies	Tasks & Examples	Notes & Elaborations
3.2	Public Education Department: include climate change in science and social studies performance standards; identify (a) gaps in climate change education, and (b) curriculum to fill any gaps.	• Include concepts of locally grown food, global population impacts, and so on. • Incorporate renewable energy and energy efficiency technology into physics curriculum. • Create "climate backpacks" to be used as teacher tools. • Link current environmental curriculum to climate change (e.g., carbon reduction benefits of recycling, conservation, and tree planting).	
3.3	Integrate "best practices" into public school design & construction to educate student (and parent's) first-hand in their communities & colleges (i.e., walk the talk).	• Investigate whether North Carolina could provide bonding for school districts to fund energy efficient construction. • Include in-building signage & displays to explicitly point out efficiency aspects built in to public buildings.	
3.4	Promote research into climate change and solutions at state universities.	• Provide funding for climate change research, award scholarships.	• Include research money for social justice implications of climate change (not just science).
3.5	Integrate climate change into existing and/or new educational competition programs (e.g., Envirothon and science fairs).		

	Measures & Strategies	Tasks & Examples	Notes & Elaborations
3.6	Work with science centers, zoos, and museums to include a climate science focus appropriate to their core mission.	• A key area for an Outreach Coordinator to focus on.	• Examples exist in other regions (e.g., Clean Air-Cool Planet science center initiative). • Could provide speaking opportunities for teachers; have college professors host forums for high school students on weekend, etc.
3.7	Introduce core competencies on climate change into professional licensing programs (e.g., energy efficiency in building design and construction and use of recycled materials).	• Promote the calculation of carbon footprints and creating a carbon reduction plan.	
4.	**Target Audience: Community Leaders & Community-Based Organizations** (Institutions, municipalities, service clubs, social & affinity groups, NGOs, etc.) Recognize leadership; share success stories & role models; expand involvement and participation; within civic society.		
4.1	Identify individual community leaders who are acting effectively on climate change; showcase and share their successes.	• Enlist/encourage them to be a de facto "speakers' Bureau." • Host discussion forums featuring them.	• include all walks of work and life (e.g., retail, services, manufacturing, healthcare, auto, and facilities). • Put examples (such as guidance, links, and contacts) up on the Web clearinghouse.
4.2	Identify "late bloomer" individuals and target a special effort to include, educate, and prod them to act.		

	Measures & Strategies	Tasks & Examples	Notes & Elaborations
4.3	Engage associations and participate in their meetings periodically to educate them about climate change and sector-specific mitigation actions.		
4.4	Develop statewide recognition program(s) for community leaders and entities.		
4.5	Organize & host outreach events that focus on leading by example, sharing how-to, co-benefits, illuminating financial risks and opportunities, and so on.		
4.6	Identify, assist, and leverage community-based organizations with expertise or interest in climate-related issues.	• Faith community • Service clubs; sportsmen; recreational/hobbyist groups • Metropolitan planning organizations • environmental, social, & civic advocacy organizations	
4.7	Work with community-based organizations to identify & build upon climate issues related to their core mission.	• Public health vs. new disease vectors? • Low-income vs. additional stressors?	
4.8	Support and facilitate outreach and education within community-based organization regarding climate change issues and actions.	• Provide content for websites, newsletters, List Servs? • Coach & assist community Outreach coordinators?	

	Measures & Strategies	Tasks & Examples	Notes & Elaborations
4.9	Develop & coordinate a network of community-based organizations acting on climate change so they can link up, organize joint events, and so on.	• Community Outreach coordinators? • Assistance in organizing	
4.10	Encourage cities to join ICLEI's[5] Cities for Climate Protection program.		• (Formerly 4.14 on CC Catalog).
4.11	Encourage cities to join the US Mayors Climate Protection Agreement.[6]		• (Formerly 4.15 on CC Catalog).
5.	**Target Audience: Business and Industry** Promote best practices, recognize leadership; share success stories & role models; expand involvement and participation.		
5.1	Extend training programs for RCI building and facility operators.		• (Formerly 4.5 on CC Catalog). • From "Recommendation A-1" and "Recommendation LT-1" in the 9/1/05 CSA report.
5.2	Promote energy-tech economic development.		• (Formerly 4.3 on CC Catalog).
5.3	Promote R&D & demo projects for economic development.		• (Formerly 4.4 on CC Catalog).
5.4	Promote combined heat and power (CHP) in order expand its use and technological penetration.		• (Formerly 4.8 on CC Catalog). • From "Recommendation A-1" in the 9/1/05 CSA report.

[5] See www.iclei.org.
[6] See http://www.ci.seattle.wa.us/mayor/climate/.

	Measures & Strategies	Tasks & Examples	Notes & Elaborations
5.5	Inform sources of the advantages of registering GHG emission reductions.		• (Formerly 4.13 on CC Catalog). • From "Recommendation A-4" in the 9/1/05 CSA report.
5.6	Develop and provide concrete information on co-benefits to entities in order to boost their climate efforts.		
6.	**Target Audience: General Public** Increase awareness and engage in climate actions in personal and professional lives.		
6.1	Educate broadcasters, reporters, editorial boards, etc. about climate change, the risks it imposes, and solutions.		
6.2	Work with state broadcasters and print media associations to develop & run climate change public service announcements; post billboards.		
6.3	Conduct public polling to benchmark strength and depth of climate understanding; track over time to measure progress and better tailor outreach efforts.		
6.4	Keep a high profile on climate change issues and actions through regular public mention by Governor and other public leaders.		
6.5	Develop and use a state-based "brand" on climate awareness and action.		

	Measures & Strategies	Tasks & Examples	Notes & Elaborations
6.6	Develop & maintain a state climate change website for the public; establish & maintain a web-based clearinghouse for climate change information and education resources.	• Link to scientific developments, What you can do, How you can help, What the state is doing, etc.	• Post annual progress reports on commitments, plan implementation, etc.
6.7	Reinforce sources (causes) of GHG emissions, and the need to implement the State Energy Plan.		• (Formerly 4.1 on CC Catalog). • From Recommendation LT -2 in the 9/1/05 CSA report.
6.8	Work with existing, company-outreach efforts to customers (e.g., utilities) to enhance awareness of climate change issues & actions.	• Retail advertising and/or "bill stuffers" • Environmental disclosure of electricity fuel mix/emissions; recycled content, etc. • Product messages (e.g., yogurt labels)	
6.9	Promote local farm produce.	• Advertise hours and locations of farmers' markets • Encourage local grocery stores to stock local food items	• *(Formerly 4.10 on CC Catalog).* • Appendix D – Preliminary Analysis of Selected Mitigation Option Options: Agriculture and Forestry, Support Local Farming/Buy Local.
6.10	Promote clean fuel technologies.		• (Formerly 4.2 on CC Catalog).
6.11	Promote green power in order to expand subscription.	• Include subscription information in every monthly utility bill	• *(Formerly 4.7 on CC Catalog).* • *From "Recommendation A-5" in the 9/1/05 CSA report.*

	Measures & Strategies	Tasks & Examples	Notes & Elaborations
6.12	Require environmental disclosure on utility bills.		• (Formerly 4.9 on CC Catalog). • From Appendix C – January 2005 Revisions to the State Energy Plan (SEP), Alternative Energy Sources: Exec-10.
6.13	Add GHG to Air Awareness efforts.		• (Formerly 4.12 on CC Catalog). • From "Recommendation A-7" in the Sept. 1, 2005 CSA report and State Energy Plan (SEP).
6.14	Host a training/informational table at Earth Day, or create a "Climate Day" event.	• Provide activities and educational materials for all age groups and expertise levels	
6.15	Develop a speaker's bureau.	• Include experts from each sector (Agriculture, forestry, energy, waste, faith, tourism, business, education, etc.).	
6.16	Develop a carbon calculator (web-based).	• Accommodate for calculating family homes, businesses, schools, and public buildings.	
6.17	Create a tax credit Web site.	• Provide a one-stop resource for all available state and federal tax credits (e.g., auto or home energy) for consumers who are making global warming pollution reductions.	

Cross Cutting Issues Technical Work Group
Adaptation Issues Matrix

	Issue	Potential Effects or Impacts	All Possible Responses	Preliminary Recommendation
A. Coastal Resources				
1.	**Tropical Storms**	• Loss of barrier islands, property damage, disruption to local and regional economies and tourism, higher insurance rates.	• Buyout of land in hazardous areas, upgrade building codes, state insurance pool, beach nourishment, and retreat from highest risk barrier islands and low-lying lands. • Develop a beach and inlet management plan (underway).	• The General Assembly should enact legislation to require sellers of coastal properties to disclose potential hazards to buyers. The coastal hazards disclosure should accompany all real estate transfers of properties with oceanfront, sound or creek frontage in coastal counties.

	Issue	Potential Effects or Impacts	All Possible Responses	Preliminary Recommendation
2.	**Rising Sea Levels**	• Loss of barrier islands, property damage, serious disruption to local and regional economies and tourism. • Inundation of low-lying coastal land and structures, loss of shallow near-shore habitat for fisheries in early life stages and loss of wetlands due to hardening of estuarine shoreline, saltwater intrusion to groundwater and aquifers.	• Retreat from low-lying lands, prohibit or reduce hardening of estuarine shorelines, limit construction in 100-year floodplain, and significantly increase estuarine buffers and oceanfront setbacks. • Enact law that authorizes the state to secure a rolling property easement as sea level rises. • Require that local government coastal land use plans include a strategic plan for responding to sea level rise. • Place the highest priority for permitting estuarine shoreline stabilization on techniques that protect fisheries habitat. • Establish a series of permanent monitoring stations to measure the absolute changes in sea level rise in coastal NC and characterize the dynamics of estuarine storm surges, astronomical and wide tides and water flow. • Inventory and map the estuarine and ocean shoreline and its bathymetry, sediments, and vegetation.	• The General Assembly should create a Coastal Adaptation Program. The program should be funded through a surcharge on the NC Beach Plan (insurance pool). Funds should be targeted for the purchase of conservation easements on low-lying coastal lands; for cost share incentive with land owners the construction of ecologically beneficial erosion control structures on estuarine shorelines; and for research to provide an assessment of the physical and ecological properties of the estuarine shoreline and the potential cumulative impacts.

	Issue	Potential Effects or Impacts	All Possible Responses	Preliminary Recommendation
			• Develop policies concerning controversial economic and resource maintenance issues for the NC coastal zone in the face of potential and direct consequences of climate change. • Define a set of short-term, mid-term and long-term environmental change targets concerning what mitigation measures should be required if specific effects of climate change reach projected levels. • Develop and implement an environmental scorecard that would track ecosystem change.	

	Issue	Potential Effects or Impacts	All Possible Responses	Preliminary Recommendation
B. Agriculture and Forestry				
3.	**Forestry**	• Warmer climate may change the types of tree species that can be grown economically.	• Compile and evaluate existing research on the effects of a warmer climate on forest ecosystems and commercially grown tree species and potential impacts on the forest products and Christmas tree industries. • Conduct research as needed to identify the potential effects of a warmer climate on forest ecosystems and potential impacts on the forest products and Christmas tree industries. • Search for alternate economic Ventures to replace the Christmas tree industry or other fir/pine trees that do well in hotter climates. Sponsor gene manipulation work to adapt existing trees.	

	Issue	Potential Effects or Impacts	All Possible Responses	Preliminary Recommendation
4.	**Agriculture**	• Warmer climate may change the types of crops that can be grown economically.	• Compile and evaluate existing research on the effects of a warmer climate on crop species to assess potential effects of a warmer climate on the agricultural industry. • Conduct research as needed to identify the potential effects of a warmer climate on the agricultural industry. • Search for alternate crops that respond well to hotter temperatures, consider growing conditions in controlled environments. Sponsor gene manipulation work to adapt existing crops.	
5.	**Pest Lifecycle Changes**	• Pests may become more virulent as temperatures rise and their habitat ranges increase. • Crops may suffer from new, foreign pests and treating them will be more challenging especially if there is no prior experience addressing their impacts.	• Research alternative methods for addressing new pests and management techniques. Develop anticipated pest problems based on problems elsewhere.	

	Issue	Potential Effects or Impacts	All Possible Responses	Preliminary Recommendation
C. Water Quality and Quantity				
6.	**Saltwater Intrusion into Aquifers**	• Loss of drinking water and industrial process water sources.	• Desalinization plants. • Use of new briny water for CO_2 sequestration. • Injection of fresh water into aquifers.	
7.	**Drought Risk**	• Limits economic growth, reduces agricultural yields, reduces aquatic habitat.	• Water reuse of wastewater from tertiary treatment plants, use of cisterns and rain barrels, water conservation techniques.	
8.	**Flooding**	• Stronger storms will bring flooding causing displacement of communities through loss of homes, and potentially severe impacts on agricultural operations and managed forest lands.	• Collect flood waters to replace water supply capacity lost from aquifers. • Develop added flood protection schemes, including impoundments, zoning, changes, and the addition of public right of ways.	

	Issue	Potential Effects or Impacts	All Possible Responses	Preliminary Recommendation
9.	**Storm Water Runoff**	• Flooding, water quality degradation, scouring of stream beds and banks, loss of fisheries habitat.	• Manage storm water onsite, utilize low-impact development techniques, or prohibit construction in the 100-year floodplain. • State law that requires development to capture and treat storm water onsite from the 10-year 24-hour storm. • Create a low-impact development unit within the Division of Water Quality to assist developers to design development projects that utilizes low-impact development techniques to protect water quality and prevent flooding by managing storm water onsite. • Prohibit development or redevelopment within the 100-year floodplain.	
D. Air Quality issues				
10.	**Fine Particulate Concentrations**	• Premature death, lung disease, aggravation of respiratory and cardiovascular disease, decreased lung function, asthma attacks, and certain cardiovascular problems such as heart attacks and irregular heart beat.	• Determine air quality strategies necessary to compensate for increased emissions associated with increasing temperatures.	

	Issue	Potential Effects or Impacts	All Possible Responses	Preliminary Recommendation
11.	**Ground Level Ozone Increases**	• Damage and irritation to lung tissue. • Reduced lung capacity. • Aggravated asthma. • Increased susceptibility to respiratory illnesses like pneumonia and bronchitis. • Ozone in the lower layers of the atmosphere contributes to global warming. • Damage to plants. • Oxidation of building materials.	• Determine air quality strategies necessary to compensate for increased emissions associated with increasing temperatures.	
12.	**Visibility Impacts**	• Degradation of scenic vistas at national parks and wilderness areas.	• Determine air quality strategies necessary to compensate for increased emissions associated with increasing temperatures.	

	Issue	Potential Effects or Impacts	All Possible Responses	Preliminary Recommendation
13.	**Increase in Pollen/Mold Spores**	• Cardiovascular disease, respiratory disorders such as asthma, emphysema and chronic bronchitis, and allergy problems.	• Public awareness measures. • Public awareness measures.	
E. Public Health				
14.	**Insect, Tick and Rodent Borne Diseases**	• Increased risk of diseases not previously seen in the state or increases in existing vector borne diseases.	• Study how potential climate changes can create the environment for previously unseen or rare vector borne diseases to exist (e.g, malaria and dengue fever.). • Strengthen state and local public health infrastructures to include improved disease surveillance, prevention, and response capabilities.	

	Issue	Potential Effects or Impacts	All Possible Responses	Preliminary Recommendation
15.	**Heat-related Illness/Death**	• Increase in heat related deaths and illnesses to sensitive populations during extreme heat waves.	• Study impact of extended heat waves on sensitive populations. • Develop possible responses for sensitive populations to minimize the impact of severe and prolonged heat waves. • Develop a strategy for providing and communicating heat wave behavioral adaptations such as air conditioning availability and increased fluid intake.	
16.	**Water and Food-Borne Illnesses**	• Increased potential for water and food borne diseases due to extreme climate events.	• Changes in building codes and zoning to prevent storm and flood damage. • Design of sewer and storm water systems to prevent fresh water contamination. • Increase public health surveillance systems to detect and quickly contain disease outbreaks.	
	F. Economic Issues			
17.	**Loss of Ski Area Viability**	• Decrease in the number of ski-able areas and decrease in number of ski-able days in the year as temperatures rise.	• Increase tourism advertising for non-ski-related activities in spring, summer, and fall months (e.g., mountain biking, hiking, and adventure racing). Develop infrastructure for multi-use, nice-weather mountain exploration (e.g., gondolas).	

	Issue	Potential Effects or Impacts	All Possible Responses	Preliminary Recommendation
18.	**Loss of Homes and Community Displacement**	• Ongoing sea-level rise and stronger storms could eventually lead to the loss of inhabitable communities on the coast. Homeowners with beach front properties and other areas prone to flood (including low-income communities) may be required to relocate – costing the towns, counties, state and federal government.	• Survey vulnerable current inhabited areas, develop relocation plans and contingency measures in the event of emergencies. Be clear on economic support for covering relocation costs comes from.	
19.	**Loss of Fishing Tourism**	• As waters warm in the mountains, fishing for trout decreases as a tourism opportunity.	• Redirect tourism emphasis from fishing to non-climate impacted tourism industries, encourage other forms of fishing for species that are more heat-tolerant.	
			G. Other Issues	
20.	**Wildlife and Fishing Impacts**	• Losses to commercial fishing from strong tropical storms. • Disruption of normal fishing cycles, loss of habitat. • Warmer fresh water decreases viable habitat for cold-water fish species like trout.	• Consider emergency preparedness to stock creeks with fish post-storm and flooding instances. • Prepare public education materials to increase awareness of species disturbance and lost habitat.	

	Issue	Potential Effects or Impacts	All Possible Responses	Preliminary Recommendation
21.	**Insurance Industry**	• The potential effects or impacts associated with many of the issues previously listed may increase insurance rates or may cause cancellation of insurance policies and other related issues.	• Insurance companies are evaluating the effects or impacts of climate change on the insurance lines they offer and are evaluating how to manage risk associated with losses believed to be cause by climate change.	

Preliminary Draft Results

Economic Impact Analysis of Bundled Climate Mitigation Options

Prepared For the North Carolina Climate Action Advisory Group

N.C. Legislative Commission on Global Climate Change

David Ponder & Jeffry Tiller

October 23, 2007

Overview

- Introduction to N.C. Energy Scenario Economic Impact Model
- Selection of Policies
- Flow of Data Processing
- Preliminary Draft Results
- Next Steps

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N.C. Energy Scenario Economic Impact Model

- Developed in 2005 for the N.C. Energy Policy Council
  - Skip Laitner, U.S. Environmental Protection Agency
  - Doug Arent, National Renewable Energy Laboratory
  - Christopher Larsen, ABB Group
  - Jeffry Tiller, Appalachian State University Energy Center
- Peer reviewed by Adam Rose, PhD. Univ. of Southern California
- Served as basis for similar analysis in Arizona, Colorado, Florida, Iowa, Michigan, Ohio, and Texas

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Input-Output Modeling

- Conceptualized by Nobel laureate Wassily Leontief
  - Describes relationship among sectors of economy
  - Outputs for one sector are inputs for another
  - Multipliers measure ripple effect due to changes in demand
- Core of N.C. Energy Scenario Economic Impact Model
  - 39 x 39 economic sector matrix
  - Aggregated from IMPLAN 2004

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Impact Analysis

- Impact model captures direct, indirect, induced effects
- Employment
  - Total full and part-time employment, not FTE's
- Income
  - Employee compensation & proprietor income
- Total Value Added
  - Income
  - Rents, royalties, dividends & profits
  - Indirect business taxes

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Economic Impact Analysis of Bundled Climate Mitigation Options
Appalachian State University Energy Center

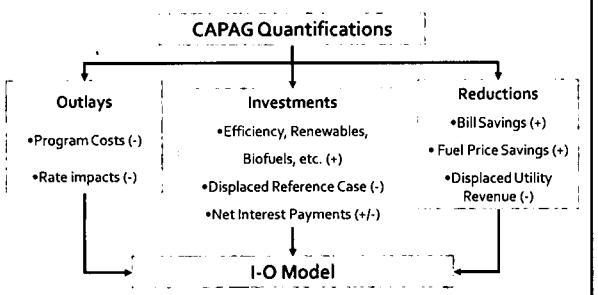
Policy selection and bundling

- 24 bundles representing 31 policy options from CAPAG
  - 7 Energy Supply
  - 10 Residential, Commercial, Industrial
  - 10 Agriculture, Forestry, Waste
  - 4 Transportation & Land Use
- Represent more than 90% of greenhouse gas emissions reductions

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Preliminary Draft Findings

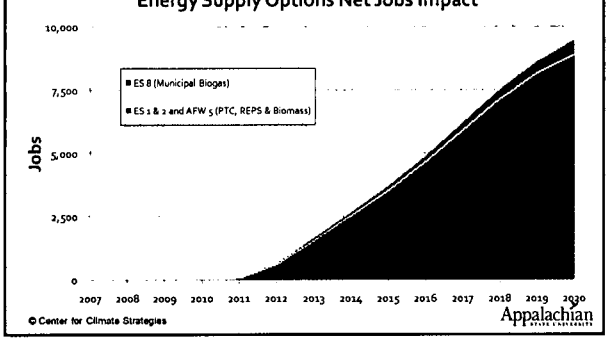
- **Cumulative Annual Net Jobs, 2007-2020: 328,738**
  - Energy supply options: 45,996
  - Demand side options: 132,985
  - Agriculture, forestry, & waste: 149,757
- **Cumulative Income , 2007-2020 (millions, 2004): $14,210**
  - Energy supply options: $3,122
  - Demand side options: $4,632
  - Agriculture, forestry, & waste: $6,455
- **Cumulative Value Added , 2007-2020 (millions, 2004): $20,561**
  - Energy supply options: $5,887
  - Demand side options: $4,449
  - Agriculture, forestry, & waste: $10,225

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Energy Supply Options Net Jobs Impact



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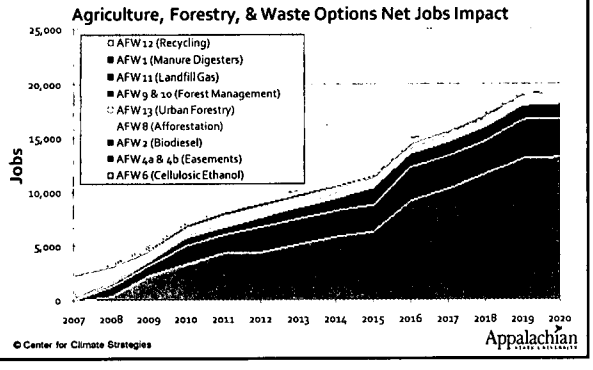
Economic Impact Analysis of Bundled Climate Mitigation Options
Appalachian State University Energy Center

	0	0	1	3	7	53	132	214	299	400	524	629	724	803
(Municipal Energy)	0	2	7	16	29	48	73	105	145	195	254	325	408	503
All Policies	0	2	8	19	36	100	204	318	445	595	768	954	1,132	1,306

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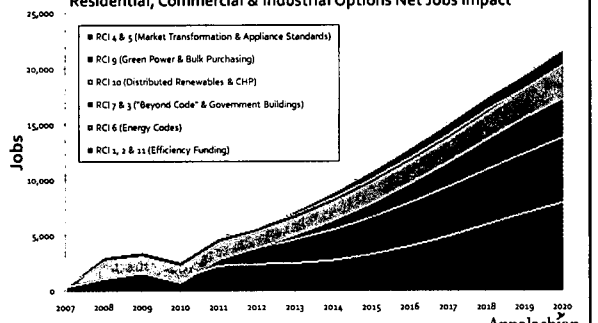
	(1)	10	9	10	9	9	8	8	6	6	4	5	6	7
AFW 2 (Biodiesel)	0	15	24	53	52	63	75	88	124	103	106	109	112	115
	3	32	35	65	66	95	97	98	100	129	130	132	161	162
AFW 6 (Cellulosic Ethanol)	0	24	155	234	314	324	386	448	496	722	824	952	1,083	1,113
	4	4	5	5	19	19	23	26	30	30	42	54	66	78
AFW 9 & 10 (Forest Management)	0	0	12	21	27	29	27	25	23	21	19	17	3	-8
	3	5	6	7	7	8	9	9	10	11	11	13	14	14
AFW 12 (Recycling)	0	0	0	0	0	0	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
	36	27	16	14	12	10	8	6	3	(1)	(7)	(16)	(33)	(85)
All Policies	160	194	300	438	514	557	621	687	761	985	1081	1208	2350	2369

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Economic Impact Analysis of Bundled Climate Mitigation Options
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Residential, Commercial & Industrial Options Net Jobs Impact



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	19	62	78	6	45	13	(22)	(44)	(47)	(36)	(12)	21	56	91
RCI 4 & 5 (Market Transformation & Appliance Standards)	0	0	0	0	0	(16)	(5)	2	6	6	5	5	4	3
	0	(3)	1	(15)	26	63	99	133	167	201	231	263	293	321
RCI 7 & 3 ("Beyond Code" & Government Buildings)	0	(11)	(23)	(36)	(32)	(24)	(3)	18	41	68	97	128	159	180
	0	26	27	28	29	30	30	30	30	29	29	28	1	(1)
RCI 10 & Distributed Renewables & CHP)	0	94	90	91	94	93	93	107	123	137	151	168	195	233
All Policies	19	168	173	74	161	158	192	247	319	404	501	613	709	827

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Next Steps

- Complete technical review by CAPAG facilitators
- Complete TLU options analysis
- Complete final report

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Acknowledgements

❖ CCS Team
- Dan Wei, David Von Hippel, Alison Bailie, Bill Dougherty, Stephen Roe, Randy Strait & Kathryn Bickel, Tom Peterson

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- Jason Hoyle, Jeffry Tiller & Dennis Grady

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Preliminary Highlights

Economic Impact Analysis of Bundled Climate Mitigation Options

Prepared For the North Carolina Climate Action Advisory Group

N.C. Legislative Commission on Global Climate Change

David Ponder & Jeffry Tiller

October 23, 2007

Global Climate Change Commission Meeting
Thursday, 4 December 2007
10:00 a.m.
Room 643 LOB

The Legislative Commission on Global Climate Change met on Tuesday 4th December 2007 in Room 643 of the Legislative Office Building with Representative Pricey Harrison presiding. Other members present were: The visitor registration is Exhibit A.

Representative Harrison called the meeting to order and gave the floor to Mr. Givens, Commission Counsel, for introductory remarks.

Mr. Givens called the commission member's attention to revisions in schedule of the agenda in respect to the February 11th and 12th meetings. Considered will be Emerging Issues Forum, which is going to focus on energy this year to be held at the McKimmon Center, NCSU and a business Meeting 2:30 to 3:45 in Room 2, McKimmon Center, NCSU . Mr. Givens advised the commission that there would be a registration fee but legislative members on the commission would not be charged a fee and that other members of the commission would be reimbursed at the discretion of the Emerging Issues Institute. He reminded them that they needed to turn in reimbursement forms. Mr. Givens announced that Dr. Pachauri, The chairman of the International Panel on Climate Change, was a co-recipient of the Nobel Peace Prize in 2007, would be a speaker at the forum. Dr. Pachauri is also a graduate of North Carolina State University. Mr. Givins informed visitors that in conformation with open meeting rule, the public would not be responsible for registering or paying a registration fee to attend the Forum

Today's agenda involves an in depth analyses and decision points with respect to the recommendations from CAPAG of Climate control. There were five technical working groups. Today the commission will be working on Agriculture, Forestry, and Waste technical working groups. Some members who have been involved with CAPAG are Robert Slocum and Paul Sherman. Hopefully we will have an open discussion and motions decisions that you want to make concerning the recommendations that have been made by CAPAG. Counsel again reminded the members of the Commission to turn their reimbursements forms and reminded visitors to sign the Visitors Sign in sheet at the rear of the committee room.

Representative Harrison introduced Timothy Profeta, speaking as Jane Pryor, Federal Director of the Nicholas Institute for Environmental Policy Solutions to report on federal activities related to global climate change. He in keeping with the pursuits of the commission should some degree be well calibrated to what the federal government may or may not do with Climate change. So that NC as a state is well positioned to takes opportunities at the Federal Action. Mr. Profit told the commission that the Lieberman Warner Climate Change Bill, a proposal to cap Greenhouse Gases, has passed out of sub-committee and is being considered tomorrow in the Senate Environment Public Works Committee. . Members hope to vote it out of Committee and put it to the Senate floor but the vote is predicted to be very tight (one to two votes). In his opinion the bill will not be law this year but it will be in its final form. The bill is a proposal to cap greenhouse admission gases utility such as 70% reduction by 20-50 and trade entities under the cap or sell to another group who wants to w the bill has a robust program for Forestry and Agriculture sectors of the economy. Senator Pittenger had a question concerning how the bill relates to HOC 23. Mr. Profeta explained that the bill covers all six major gases. There are two programs under the bill that allow grants to get sellable credit. Dr. Smith had a comment on how to deal with Allocations in this bill. There has been a question and much discussion concerning the percentage of auctioning off; the auctioning off of pollutants has risen from 24 % to 74%. The question is should it be 100%. Tim Rogers at Duke has been working on this. Over the next 18 months this there will be robust

discussion concerning the auctioning off at 100%. Dr. Smith offered to share with any one the testimony that has been concerned with the request to auctioning at 100 %. Mr. Profit informed the commission that the Energy Bill is presently in Conference Committee. The provisions in this bill are renewal portfolio standards, fuel economy efficiency standard efficiency fuel standard for vehicles and a robust tax package. The bill does not have the support in the Senate. It has been very controversial and unfavorable. There has been a deal struck with the auto industry. The fuel standard will be raised economy from 35 miles to 22 miles an hour. Mr. Profeta does not believe the renewal program will become law.

Next on the agenda is Mr. William L. Chameides, new Dean of the Nicholas School of the Environment. Duke University. Mr. Chameides will discuss the extent to which carbon offsets may be reliably identified and qualified. New book, The Earth's Farms and Forests Low Crab Economy written by Mr. Chameides. What are offsets-they are Greenhouse gases. You can offset Carbon Cycle where Carbon Dioxide is taken up in the atmospheric Co2. Please refer to Exhibit one "Real and Verifiable Carbon Offsets" – Mr. Chameides presentation. Co2 is increasing because fossil fuels are being burned. We need to quit burning fossil fuels. Temporary Solution to the problem is land management. We need to capture methane emissions from manure, land fills etc. Farmers could be paid to capture the methane and store more carbon in the biosphere. Tim Cerich asked if there are any new programs being considered. Dr. Chameides answered that there is a bill in congress to cut CO2 about 15 % but he feels that it should be 20%. He said that the ideas of offsets have to be correctly done and additionally, it is important that the process for creating offsets be real and variable. Offsets have gotten some bad press and cited a web site www.cheatneutral.com to the commission. He stressed that offsets must be creditable and that the regulators, buyers, and people must have confidence that offsets are real. The process for getting credible offsets is as follows: 1.Set a baseline (what emissions would be in the absence of the offsets), 2. Assess leakage (Sequester carbon) for example you decide not to cut down your trees to send to the lumber company and save the carbon, but your neighbor cuts his trees down and sends the lumber to the pulp and paper mill to make up for loss of the lumber that you decided not to cut. Then, you do not get credit for preserving your trees. This is leakage. 3. Measure the changes in the soil, take samples of the soil and have it tested, 4.IndependentlyVerify (have an auditor verify what the farmer has done), and 5. Register offsets. Keep a detailed account of what one has done in the registry of the offsets.) The most important action is measuring regularly samples of soil to show carbon is building. Dr Chameides told the commission that off sets have a huge potential in North Carolina. Senator Albertson asked if anyone currently was doing No Till and would we have to do soil samples overtime and how much. Dr. Chameides answered that some projects were in effect and that numerous experiments were being done to show that No Till builds carbon in the soil. Auditors must verify. Representative Allen asked if sequestering forestry meant delaying cutting and the answer was yes. She did not feel that it was fair to not receive credit for sequestering and would like to hear from the forestry Association. Dr. Eggers stressed that the "name of the game is sequestration." She brought up the action "Bio Char" where carbon gets re-admitted to the earth. What if people sold land to people who would not cooperate and continue to sequester. Dr. Chameides explanation was that to qualify for offsets a landowner needs to own the land. If he sells it to a company then the company owns the carbon in the soil. There must be a contract. If carbon returns to the atmosphere then the owner needs to make up offset in another way or someone might least the offsets such as a power company. Representative Harrison asked what is "Bio Char"? The answer was darker soils were found in the Amazon where people had settled and would bury organic matter and char the organic matter. They found that plants grew better and faster, the ground retained water and the agriculture flourished. It was found that carbon put in the ground a long time ago is still there. Bio Char is a good sequestion solution. Co- Chair Garrou wanted to know cost per ton of carbon in monitoring and assessing leakage. Dr. Chameides said that it is a great ;opportunity but we must also recognize that if we're in a capped economy we are letting the market place to sort out and individuals will try to make a profit, others might try to innovate and try to figure out how to do it a cheaper way. He did not necessarily want to get into the economics in great detail but felt we should allow land managers

and farmers to compete in the carbon market. It could be a great boom for what's in the climate. Tim Profeta commented that provisions in the federal legislative process concerns putting governing money into projects in and marked and lowering transactions. Representative Carney wanted to know where to register offsets. Mr. Profeta said that were a lot of places but named The Chicago Climate Exchange in Chicago and Environmental Resources Trusts. He said that Project managers will do registrations. Dr. Chameides said that there are different registers and they have different standards. Some are more stringent than others on what they will register. The next question was asked by Co-Chair Representative Harrison. She wanted to know what is going on at the National level. Dr. Chameides said that we are much further along that the European Countries we have a much greater potential than Europe to be competitive internationally. What is not appreciated by many is the fact that 20% of CO2 is emitted from carbon off sets in Europe is the burning of the rain forests which take place in Indonesia land Brazil. There have been a number of proposals made. One is Compensated Reductions which would compensate those who would reduce the rate that deforest which would help in lowering CO2 emissions and would be rather inexpensive. This proposal is being discussed in Bali as we speak. Mr. Profeta added that Europe doesn't have offset provisions. Some of the Europeans are doing projects in the US. The Europeans look toward a voluntary market they have no mandatory system. Representative Thomas asked if there was no standard law for agencies that sell offsets; no federal policy in place it is it all voluntary. Dr. Chameides said that federally have a standard for Climate and, Representative Thomas felt that there needs some law in place Tim Profeta answered that Federal legislation is looking at one standard VCS and a CFTC would regulate the commodities Market and should have some rules is place in a couple of years. Mr. Sherman asked if there was any consideration to alternatives to monorting individual projects because of the problems of leakage and terms of contracts, etc. Are not alternatives that we can look at statistics of the average of research that are based on location, soil samples and climate? Should we be looking at a modification factor that devalues the credits based on the perception of and leakage and regression of certain percentage of those credits? Dr Chameides said that leakage is the most easily best developed through economic modeling, elasticity of price, and demand. There needs to be more modeling than monitoring; however there needs to be some monitoring. Uncertain results will devalue the offset. Mr. Sherman asks Mr. Chameides if his proposal is to do more modeling than monitoring depending on the project and he answers yes. Dr. Eggers wanted to know how we deal with double dipping in off sets. Dr. Chameides response is that in principal it is additionality. One has to show that as a result of your activity, you have decreased the amount of CO 2 in the atmosphere. Dr. Chameides used the example of Corn enathanol – Corn is taking the place of soybean crops in the United States. however biofuel might not be an offset. Brazil and other countries are cutting down their rain forests in order to grow soybeans. Mr.Slocum, Executive Vice President North Carolina Forestry Association, questioned Dr. Chameides about the positivity of active management of forestry and felt that Dr. Chameides had implied that it was a negative when it comes to climate. Dr Chameides responded that it depends on how the wood is used after is has been cut down. A regulatory agency would have to workout a detail analysis of the products themselves. Mr. Slocum brought up the delaying harvesting and how long. He felt that active management of the forests is the answer and that museum management; "look but don't touch" is not the answer. Dr. Chameides agreed and said the concept of sequestration of the forests is a management issue. So not plant the forest and walk away. Mr. Profeta said that we are on line with EPA and there are tools in place to help make project plans. Dr Chameides feels that there needs to be a time line, a plan for a project and go forward with it. Mr. Hopkins had a question what markets would Dr. Chameides advocate. Should there be a Local market, Global market, Regional Market and should the markets be distinguished as to their products. Dr. Chameides said that in general the size of the markets needs to be as large as possible. How you account for leakage is an economics point of view using objectives measures of elasticity of demand and elasticity of Price. You can calculate what will happen in demand as prices increase. In conclusion Dr. Chameides said the size of the market is key in principal and it should be an international market. Dr. George Everette said that in the working group Climate Action Plan process looked at changes in greenhouse gas emissions verses the cost. He wanted to know if a scale could be

charted from graph #2 in Dr. Chameides slide presentation to compare Vehicle mileage and look at a scale differential. Please refer to page 7 of Real and Verifiable Carbon Offsets.

Next on the agenda was a Discussion of Opportunities and Recommendations for Carbon Offset Projects in North Carolina's Agriculture and Forestry Sectors by William C. McDowell, III, Southern Forest Projects Manager Environmental Defense. Mr. McDowell entertained questions from the commission Representative and Co-Chair Harrison wanted to know if the 1.7 million tons for swine carbon emission was based on methane. The answer was yes, and she noted that methane is 20 times more potent than carbon greenhouse gases. She also wanted to know where we stand on the Farm Bill SB 1465. Mr. McDowell said that there is funding for offsets and a renewable energy component that could help landowners get projects started. Mr. Profeta added that the question now is there going to be a new farm bill. There is a large amount of funding for the Bio Energy Bill but it failed in the Senate. Dr.Cecich asked if the Bio Energy project is complimentary to agriculture off sets or do they have a negative effect. Mr. McDowell said that it depends on the projects. Methane is 20% more times potent than carbon. It also depends on the differential standards, some have neutral benefits and others can have net carbon benefits and there are negative effects in some activities. Dr. Smith, referring to SB 1465, wanted to know the significant impact of methane on the atmosphere. He asked if we are on a pathway to catch methane emissions in North Carolina. Mr. McDowell said that there is a need for anti aggression on methane such as hog farms. The hog farms have attracted a lot of investors to capture methane. Mr. McDowell recommended for the commission to be more aggressive in finding funding by working economically and Jane Pryor said there needs to be more investment made in Hog Lagoons. More money should be appropriated to this cause. Senator Pittenger informed the commission of an Article in the Wall Street Journal concerning the conversion of methane and other biogases being studied by major High Tech Firms and Capitol Ventures. George Givens, Counsel for the commission elaborated on SB 1425 and SB 3. According to Mr. Givens the big Energy Bill SB 3 provided for finding ways and appropriately set a side for the generation of renewable energy some of which would undoubtley would accumulate methane through capture. Senate Bill 1465 has a lagoon conversion program that is funded through the agriculture program and through appropriation. It also has a provision for a pilot program on methane capture that capted a max of fifty farms and has a max of 24 mega watts. That has a duration of about seven years that is paid for by a surcharge on rate payers and when you're talking about how you are going to fund these things, it is a matter of considerable negotiations and political sensitivity.

Co-Chair Harrison introduced Mr. Brock M. Nicholson, Deputy Director, Division of Air Quality, DENR, for a presentation and consideration of the recommendations of the Agriculture, Forestry, and Waste Technical Working Group of the Climate Action Plan Advisory Group. Before Mr. Nicholson, Mr. Givins was recognized to address the agenda. In regard to this agenda item he brought to the commission's attention a memo from the Center of Climate Strategies regarding the technical and economic qualifications as received for information and asked that it be put in the record. See Attachment The Center for Climate Strategies dated December 3, 2007, Subject: Center for Climate Strategies Technical and Economic Qualifications. Mr. Brock's opening remarks explained that the CAPAG group was made up of many NC Volunteers, stake overs, and members of this commission. The recommendations that will be the focus of the meeting will be from the Agriculture, Forestry and Waste Areas which are from five working groups or Twig working groups. The recommendations received unanimous consensus from the CAPAG after initial deliberations in the working groups. Mr. Brock said that his presentation would introduce to the commission some thoughts or suggestions by this group and that regarding the course of action that the commission and policy makers in this state might make from this point forward to realize implementation of these recommendations. Mr. Brock, next, began a slide show presentation. See Attachment: DAQ Suggestions for Course of Action on CAPAG AFW Recommendations. The basic criterion that Mr. Nicholson used in suggesting these recommendations is the certainty of whether or not there were savings or costs net up front costs in this analysis and

specifically in the CAPAG analysis. The recommendations, particularly those calling for legislative action is suggested because the CAPAG analysis suggest that there may not be an up front savings net of cost, but long term maybe there would be savings in economic benefits and that would be very positive especially in Jobs. There would be the opportunity to create a whole series of jobs in the process. The idea that there is the need for the Legislature to be involved is because there are complex social questions and should be dealt with by the highest level of policy making in the state which is the legislature. See Attachment: Appendix H of the Draft Mitigation Options for Controlling Greenhhouse Gas Emissions which elaborates and explains at length each recommendation presented in the slide presentation.

Thomas Peterson, President and CEO, Center for Climate Strategies and Stephen Roe, Senior Scientist, E.H. Pechan and Associates and Facilitator, Agriculture, Forestry, and Waste Management Technical Work Group and Lead Consultant for Emissions Inventory, Center for Climate Strategies, Dennis W. Hazel, Assistant Professor and Extension Specialist Department of Forestry and Environmental Resources, NCSU,Christopher B. Hopkins, Outreach Associate, Department of Forestry and Environmental Resources, NCSU, M. Paul Sherman, Director of Air Quality and Energy Programs, North Carolina Farm Bureau Foundation and Robert W. Slocum, Jr., Executive Vice President North Carolina Forestry Association were next on the agenda to elaborate on the recommendations, lead discussions and answer questions.

Mr. Peterson introduces Steve Roe who will walk the committee through each of the recommendations on Agriculture, Forestry and waste made by CAPAG. Mr. Roe was the leader of the technical work group. and will show the intent and structure of the options. Mr. Peterson also asked that Bob, Paul, Dennis and Chris to elaborate and be involved in Q and A regarding the individual recommendations. Mr. Peterson noted that the consideration of these recommendations included economic opportunities through market base systems, which included offset opportunities. Considerations of these actions were not limited to their potential as offsets in a credit market either. There are much broader and intergrated opportunities for these actions to move forward and create economic opportunities and emission reductions in NC. So the group looked at a broad net of potential approaches that would be appropriate and sensible as they structured the options and the listing of them is in table form in the beginning of the Chapter of CAPAG on Agriculture, Forestry and Waste Technical Working Group Recommendations. See Attached Appendix H. Each recommendation has a write up that has a dozen elements that were specifically taking in the design and analysis of the options is summarized in the report.

Mr. Roe presents slides to the members. See Attachment DAQ Suggestions for Course of Action on CAPAG AFW Recommendations which is an outline of the recommendations in Appendix H. Steve told the members the costs net end up with a cost savings. He said that the over all costs ended up in a wash. He also said that all the recommendations received a unanimous report and that there were no objections from CAPAG.

Next Mr. Peterson asked that Stephen, Dennis, Paul or Bob elaborate on each option and take questions from the members. Paul spoke on option AFW-1, Manure Digesters and Energy Utilization. He said the cost figures used in this opinion was based on a lot of a NC data project especially dealing with swine. It was a project that doesn't fit in a nice category as where current regulation of swine waste didn't quite meet the now current regulations for a new Lagoon not costs based on a project that just catches methane and doesn't actually look at additional treatment. Most of the costs were based on the Barum Farm project. Steve said that the group used the Barum Farm project that was done in North Carolina which served as the base for the information that the group looked at the Hog Farm. The work group felt that it was good for NC specifically a bit conservative on the cost side as compared to other costs that we are seeing nationally and coming out of projects of projects in other states. Paul added that in his opinion that the status of swine waste to the electricity to the set asides in Senate Bill 3 is .2% of the electricity

generated in the state. He said he was not sure where it falls in the goal that CAPAG has put forth. It is relatively close the CAPAG that we have here is a little higher than n the goal as to what the set aside in Senate Bill 3.

Co Chair Harrison asked is the reference in AFW60 to starch base ethanol corn? Paul answered yes, that basically it is mid-west corn based ethanol and is the predominate source of ethanol in the US today. Rep. Harrison said she had heard that there might be more greenhouse gases emissions associated with corn-based ethanol than associated in fossil fuel. She asked if the group was recommending the production or use of corn-based ethanol. Paul said that the group wanted to show that not only celulosic ethanol be looked at but wanted to show within the options and analysis the benefits of utilizing greenhouse superior, peat stocks and methods. Contemporary wisdom is centering around a slight benefit associated with corn-based ethanol on the order of 18% to 20% relative to gasoline. Celulsoic produces at least 80% benefit relative to gasoline.

Representative Harrison referred to AFW-4b and asked if the reference to the CAPG group is recommending that there be more preservation and production for biomass used for energy purposes can offset fossil fuel use. Was there some size range of tracts of land? She thought that we want to promote more forestry production and conservation as we can. Paul said that it bears some additional clarification. Under 4b we're really looking at to preserve a forest base under 4b so that we aren't losing any more ground, while other options including AFW-9 and 10, we are looking to increasing the level of productivity within the existing forest base. So if there is really no conflict that he sees. His doesn't know of any conflict in the preservation. Bob's concern is that more to do with terminology than anything else. When you say preservation keep in mind that automatically congers up the museum management- take these lands and set them aside and don't touch them- and that's not maintaining the forest base. Regarding size limit, there is no question that management gets smaller. Management options as ownership gets smaller management and management gets more difficult and more expensive. When you get below 10 acres is difficult and you have tremendous costs verses the small acreage and it makes some of these operations more difficult according to Bob Slocum.

Paul asked if there were more questions on AFW 1 and Ivan Urland had a clarifying question on under related programs Federal renewal energy production tax credits and then as it explains the cost analysis and what factors were included. It says renewable energy production census was not included but it could have a small effect on estimated cost. Did the group not include the Federal and did the group not include the State renewable energy tax credits. Paul answered: We did not include the Federal, Are you referring to the energy per kilowatt per hour tax credit? Urland was. That was the one that Paul discussed with the Ag Star program. He said that they were not sure how likely that was going to be available to us within the policy period. On the state side we exclude those with in the CAPAG process not just within our options but across all the other work groups because they are considered to be in state costs. We do take the Federal grant program into consideration.

Questions were put on hold for Dr. Crawford Brown to make a statement. We have thirteen policies that give us 3 % production in CO2 emissions. Am I doing the math right. Seems like an awful lot of policies for a tiny, tiny reduction that 8 million people in NC each with 25 metric tons comes out to be 200 million people in NC each with 25 metric tons- He then with draws this question and goes back to the question regarding the scope and benefit. The scope of these I think and what benefit do you get and if you look down these lists and this is the 1st one (AW1) I urge you as you go through this list of policies in each area there is a cost effectiveness and there's a tons reduce some of which show negative numbers which means savings and certainly we ought to encourage all of those. But when you get to recommendations that have cost per ton that are very high verses the benefit you have to question why they are on the list. I question that process even though it says unanimous consent but without having all of these in one package rather

than in individual categories, That's very difficult to do, but what would be helpful to have a pie diagram that says "here's the source of CO2 emissions per metric tons of carbon emitted from each section and then what these strategies do in cost and the reduction you get. You can do that with this report. It takes a lot of effort but I think it is important to look at that cost effectiveness test and the total emissions reduced out in 20-20 as a result of each those steps that what is very valuable.

Co Chair Harrison asks M. Peterson if he could provide a chart to the commission at the next meeting so that they could put all of this in perspective. Mr. Peterson answered Absolutely. Rep Harrison said that our hope today was to prioritize some of these suggestions. We will go through these items line by line then we'll discuss the merits of the.

The meeting was then turned over to Tom for further discussion. Mr. Profeta had a question. In the 1st two witnesses, I found some good recommendations in terms of how to seize the offset opportunity in terms of extension services educating landowners trying to create standards. Is there any place that we can fit those into this? Or would it be a thing of a separate of recommendations that would be educate land owners and create the standard encouraging investment and does that fit within the concept, should we have our own addendum. How do three recommendations fit in the thirteen.

Tom Peterson: Maybe a slightly way to frame that there are three general principals or approaches that are behind the engineering of most of these actions. One is to create more or some policy driven opportunity or need for reductions so it's really on the demand side to try to create that and to the extent possible and some market driven or market base manner. But also at a policy base manner, secondly to create or enable a supply response to put in place mechanisms whether it is financial assistance standards. education, etc. It would create or enable some response, some supply of the reductions that would meet that demand. And the third is to bring as much flexibility to that as possible so that the transition to going forward to those new actions will best be suited to the markets and parties involved in implementation, creation of demand, creation of supply of flexibility that really are behind all of these and it depends one by one on exactly what levers and mechanisms need to be put in place to do any one of those three pieces.

Mr. Profeta: What is the government's ability to grasp opportunities that are on this chart before us. I think about – well if this commission is going to recommend the policies proposal, we have to think about what is the overlaying government intervention programs, etc. I hope we will grasp the opportunities.

Tom's response to a previous question. 25% of total reductions of the action recommended by the CAPAG are from this particular batch of 13. Mr. Profeta says he wants the Big Hit. He wants 60%. He doesn't want so many policies. He wants a small number of highly effective policies.

Tom Peterson: What was considered by the group in identifying these actions was not only ones that had sheer emission reductions potential but ones that for other reasons might none the less be important to the State, certainly there's an issue of co benefits. It's also to be fair a little bit that some of the recommendations don't look, during this time period, like they are big performers, but in longer time frames, they could be important stage setting to reductions down stream. So there were a variety of considerations going into the list, and demonstrate graphically how that all plays out.

The commission moved next to AFW2, Biodiesel Production (incentives for feedstocks and production plants). Co chair Harrison asked if anyone had any thing to add to Steve's description. There were no additions or questions. Next was AFW 3 Soil Carbon Management (including organic production methods incentives). Bob Slocum had one comment to make: There was a reference in our discussion to Celulosic Ethanol. AFW 4a (Preservation of Working Land – Agriculture Land and AFW – 4b Preservation of Working Land – Forest Land were now up for discussion. Representative Harrison had a

question on Present Use value: Did you all talk about some of the existing centers, the way our Present Use Value is structured? Were you specific in that? The answer was yes there was discussion of Present Use value and Bob Slocum had quite a bit to say on, is there anything that you would like to bring out Bob? Bob: not really there are growing programs that have served landowners very well. – good stimulus to improve actively managed forestland, which is Critical to the landowners. Another answer was that there is some discussion of land use value in AFW 4a and 4b and the reason for that is we just wanted to emphasize the fact that they have shown themselves to be effective programs and want to make sure that they continue.

Dr. Eggers had a question about non working forests and what are the current policies in either of these – just incentives for maintaining land in non working, non economic short term sense? Rep. Harrison said: There are incentives set-ups and the Legislature is working on that. Lands managed for wildlife and conservation. We have some legislation that passed the house last session that's been referred to the Senate – It would allow for different categories for Present Use Value, but it didn't want to actively cultivate your timber but one that set it up for wildlife management, or conservation which provided a new category of Present Use Value and there are others that we have been addressing some in the Legislature.

Bob Slocum: The resistance to that approach comes from the counties early and you probably know this as well as I do, it is the counties that are losing a revenue source if the lands are working in the sense of generating revenue. The counties can be upset of losing that source of taxable revenue. Rep. Harrison says this is accurate. Another question was: There lots of reasons to preserve agriculture, but perhaps from a cost benefit analysis; carbon reduction is not one of them. Did you consider just to remove this recommendation because it is tail wagging is all.

Paul: Great point because it is really tough with in one table to show all of the benefits that might be achieved – carbon or otherwise. As you mentioned I think we do address non carbon benefits within the write up in the policy but it is somewhat misleading to look at only these greenhouse gas reductions related number that you see on the chart, 4a.

Tom Peterson: I think you raise an important point. I think some of the recommendations on this list were actions that the group believed were likely to move forward for reasons other than carbon management, but could be tweaked a bit to try to be as carbon friendly as possible, and in any event, the concern was to try to make sure that we could score out the benefits of those programs as they move forward whether they are enhanced or not. So we've got a record of the benefit associated with it so you are seeing some reflection of that in this on list.

Paul: A lot more of that is that it speaks to cross cutting benefits for some of these that are captured in other areas that haven't been discussed, yet specifically with this one you have some of the transportation and land use options that deal with reducing vehicle miles traveled and part of that is preserving working lands. It's fits in as a small part of the whole. When we break them out in tables like this, they sort of lose a little bit of the focus on some of the larger items.

Bob Slocum: On working lands where we said that we've lost these acres to development and lack of post harvest regeneration it implies that the lack of regeneration equates to the loss of forests land and it doesn't. Simply the lack of post harvest regeneration (intentional act of a land owner) does not equate to the loss of forest lands, in fact, the only way you're going to lose the forest land is if you put a concrete slab on it or pave it over. Nature will take care of it one way or another; it may not be as productive as if a landowner had intentionally re-forested it under a management plan. The other, with regards to forestry, it's important to understand the what land out there from a forestry standpoint is very aggressive and it's

going to require to achieve these benefits and is going to require an unprecedented level of up front costs. An investment somebody is going to have to front a whole lot of money for these things to actually be realized. And from the standpoint of carbon, the benefits are accrued over a long period of time. It's not a one to one immediate benefit. There's a lot of other reasons to do this that make great sense - economically and environmentally. Understand there are some significant up front costs that are going to be necessary to achieve these things.

Paul: I might add that the mobilization of capital is certainly a big issue that turns up in many different place. Bob you raised a very important technical point. I think we want to double check that, and correct me if I'm wrong, but the numbers that were used in terms of the base line and projected conversion rates for changes for forest – cover are from the Natural Resource Inventory NRIUSDA – those are specifically land cover conversions to develop uses which have a technical definition. Those are not land cover changes that are associated with the removal of trees that can be regenerated whether natural or otherwise at whatever level. So that's a different category and so we want to make sure haven't mixed those numbers. On another issue, I think that what comes up is that we need to reinterate the semantics, terminology working lands implication here as these lands are retained in forest cover. That is not to imply that there will be a removal of management practices on the land. Soot the intent was clearly that these could be maintained in some appropriate form of activity management consistent with carbon friendly practices. Did I get that right? Yes

Dennis tells those on the commission that they will get a complete presentation from CAPAG – The social feasible noted in the back of the Appendix. Those of you who are going to be pouring over, I guess, each of the results from all five of these work groups presumably you are going to get the complete presentation from the CAPAG. As we proceeded we noted and were aware and discussed things like fiscal feasibility or social feasibility and they are noted usually in the back of each of the policy options presented. So obviously we don't discuss everything in detail, but they are noted and considerations that are discussed. And also with respect to the forestry options 4b and 8, 9, and 10 that we'll get to and in each or those cases the policy options are largely designed around already demonstrated successful programs of some kind that are either in place or their designed to be like another program that's in place and already working.

Paul: Thank you Dennis and yes the Appendix to the report which is on the website (un audible) is long and has additional references. It has more information and we can provide that.

The Co-chair asks if there is any elaboration on AFW 5 Agriculture Biomass Feedstocks for Electricity of Steam Production. Dennis responds: I would just note again that this one runs pretty well in tandem with Senate Bill 3, and that pretty much addresses the recommendation fairly we.

AFW6 Policies to Promote Ethanol Production is now up for discussion. Chris Hopkins: Along with the other clarifications on technology assumptions I do want to add to this one is that this is also a pretty aggressive set of goals here. I think we didn't quite realize how aggressive it was when we started out. I think people had a feeling that it was, but once we started looking a little bit more at the feasibility and the availability of feed stocks to produce this much celulosic ethanol we found we're starting to but up against the ceiling of what might be available. So I think we noted the need for additional research into feed stock availability, but I think we are really approaching the upper limits of the benefit that could be achieved through this option again in tandem with TOU 7.

Steve explained that AFW 7 was moved to AFW 4b and AFW 8 Afforestation and/or Restoration of Non-forested Lands would the next option to discuss.

Dennis Hazel: My only comment would be that in response to George Everette that as you look through the cost effectiveness of each of these items, for instance nine and ten has the negative number because of the positive benefits of producing forests products and what it does within the economy. For AFW 8 there is none of that because we're talking about establishing new lands. Forest products will not be produced until a time frame beyond the scope of this analysis. These are all new stands.

AFW 9 & 10 Expanded Use of Forest Biomass and Better Forest Management. Dennis: Just a comment on the number that was given when Steve Roe was doing the presentation of $9.00 per acre for these costs. There is no practice that I'm aware of that we can implement on a tract of forestland for $9.00. That is a number that in economic terms is an annualize present value of all practices applied during the life of the stand so it's a way of allowing us to do the analysis. But we recognize that doesn't represent the cost of treating an acre of land with any particular practice. Dennis asks if that's a cost per ton of carbon saved. I think it is the metric that we have up here so its not the cost per acre it is an in put to that calculation. That's a separate calculation. Steve he did mention in puts to that cost and that he did mention $9.00 per acre annualized over all of the treatments that would be used.

Speaker's name not audible: I think on this one, I heard concern from the environmental community about the risk that some of this waste biomass currently provides some habitat for species after timbering is done and that it protects against erosion in areas where the grade is steeper. Can someone comment on whether this is a concern and whether that has been addressed in anyway?

Paul: Most of this discussion concerning this has occurred in context of the newable port standard and we've been in discussions with Environmental Defense. We talked about what would be a reasonable amount of biomass to leave on the landscape. We have general agreement that some snags and some wildlife brush piles would be feasible, relatively easy to accomplish and without any real impact to the total biomass available for energy production. Probably the largest cause of concern that remains would be the widely dispersed coarse weed debris section – what could we leave in terms of coarse weed degree widely dispersed. It's an open question as to what wildlife actually needs. We have, as far as erosion concerns go, we have four (inaudible) acts that should cover any wide scale erosion of soil into the streams and that's not al0oawed in any case biomass harvest or not. The outstanding issue is what coarse weed debris is needed by wildlife and the best we can tell is no definitive answer in the research as exists now. Nobody knows yet the need for that specific species or class of species or type of life form. So this is an open question and one that really does need some research.

Follow Up: I think would wildlife once the forest is removed being the critical habitat then, some of this becomes irrelevant. Just because we don't know wildlife and habitat needs. We know that they are non-zero. I have some concern about the same thing and it's more related to soil and soil management. Through research, I'm familiar within the Specific North West and in British Columbia that has to do mycelium inoculation of the material left on the ground and beneficial enhancement of soil and actually the significantly improvement rate of reforestation and carbon sequestration. I think the recommendations to increase the removable biomass from large areas is moving in the wrong direction for several reasons and it's not all clear to me from a climate perspective it's compelling in any way.

Paul: First of all the biomass- what would we do with the biomass – that's the question and the primary use of that biomass that would be removed is to off set co-combustion... Either use reuse carbon that's already in the eco system in the biosphere or we can use carbon that 's coming geologic sources. One has that life cycle of a year many tens of hundreds of years of life cycle. So we're basically reusing carbon that's already in the biosphere as opposed as to the stuff that is in the geological cycle. No wasn't part of our discussions. The actual – one of the critical habitats needs for wildlife in the State is early sucessional forests, Typically tropical migrant sector, that group of species.. Early successional comes from

harvesting stands that have been (in audible) numerous times. So there are some real wildlife benefits to the harvesting.

Follow up: Yet my comment was not about harvesting at all. It was about the Biomass on the ground So you can just be focusing on that, I agree with what you are saying but I think another aspect of it is obviously the issue is not just as simple as co-off setting with wood but that is we decrease the rate of carbon sequestration of the forest that replaces the forest that was cut down, Then we might not really be gaining. This needs to be thought about.

Chris: And one of the arguments is to increase the fertility and the overall carbon sequestration rate of these forests. We can do that in several ways. 1. Increase the fertility of the sites. Fertilization can get you somewhere between 60 and 80% increases in fertility of the sites and that includes low ground and above ground. 2. Concentrating on growth on larger trees which produce larger products which have a much higher durability. 3. We're taking biomass and we are offsetting coal. Good reasons to consider doing much more aggression toward forest harvesting and forest management.

Follow up: I think actually considering the effects and think we should consider using synthetic fertilizers and we don't have the run off problems and we don't have the nitrogen and phosphorus problems in our surface waters, etc., etc. Nor do we have sedimentation problems which while we have regulations in place to protect our surface waters we know sedimentation is the biggest problem and some of that comes (un audible) I don't support this as written.

Bob: I guess I would caution about trying to look at this particular option too narrowly and just focus on the so-called Bio fuels aspect. Economics is going to drive Bio fuels and I tell you right now even if you gave wood away the economics of simply moving from point A to B make it non competitive. So how much of this stuff is actually used for Bio fuels – follow the money- will tell you and how much is actually there is in pure logging residue. I've got a fair number people in my associations that actually question how much really buyable material is going unused now. I think the Bio fuels side of it maybe driven by pre-commercial finning and some are bad in using some standing timber as opposed to the residues. I think a lot of foresters share the concern about long term impacts on soil fertility, but what I think this option really does speak to is improving the use expanding use of wood products in general which when it comes to carbon, certainly is superior to concrete and steel. And I caution, don't just get caught up in the Bio fuels aspect. This is a lot broader.

Co Chair Harrison: I want to point out a concern that we had about wood in regard to the biomass issue for energy is the environmental impact of the emissions and we heard a discussion during the Senate Bill 3 about how it was actually dirtier that coal and that the (un audible) will help us develop some recommendations to get at that.

Paul: Any further discussion and 9 and 10?

George Givins. Bob Slocum did use and is correct especially with this option about this being an unprecedented size program. It's built around cost sharing. Now we just mentioned that with this option, as many others, it's not necessarily an all or nothing If it seems wise to do a portion of it, then you get the corresponding benefit and it is recognized that this would be an enormous unprecedented wrap up, particularly in place sharing program. I would add landowners do respond to cost sharing programs real favorably and when money is allocated it gets used.

Question for Chris: As you were going through the list of things that were considered, I didn't hear methane from forest residue left in place or if it just degrades.

Chris: I think methane is only produced an optic environment. You don't get large amounts of methane from forest residues unless you've got them covered over with old landfills or water. So I don't think methane is necessarily an issue with forests residues. They tend to be pretty well air rated

AFW 11 Landfill Methane and Biogas Energy Programs. Name of speaker (inaudible) where in the process did we look at solid waste incinerators?

Tom: That was not something that we looked at in this process. In both the waste management options, the first is pretty narrowly defined in making sure that we're capturing more landfill methane. Second one is really just focused on increasing recycling rates.

Follow up: Was that perhaps captured in another sub-group? Solid waste incinerators and it's impact

Tom: No, I think within our original catalog of options that we looked at waste to energy is one of those, it just was not one that the overall work group felt inclined to bring into our initial list of priorities which you are seeing here.

AFW 12 Increased Recycling Infrastructure and Collection. Representative Underhill was recognized: I just feel like this particular piece in AFW we that we need to look at and examine how other states ahead of us or behind us. Because when ever I ask people about their local recycling opportunities, everyone seems to want to do it but the local agencies are just not making that possible and a lot of the things on your list are very, very significant when a narrow number of people are involved with them. The recycling program is a place where the public can buy in and feel like they are at least doing something to help lower carbon emissions in their own wan and I think it's important to have a fairly simple piece that everyone's always throwing up that it's too expensive. I just don't think we can ignore recycling as a motivational tool in our state. The litter problem that we have is incredibly difficult. I'm glad this is on here.

AFW 13 Urban Forestry Measures Mr. Hopkins makes a statement: Looking over the numbers and taking in the earlier discussions about the overall table 6 – the two largest benefits are in terms of negative net present value are 9 and 10 and 13 and I think just looking over some of the assumptions in 13, I probably challenge whether that's an achievable number in terms of over all reductions, savings and (un audible) I will probably address them on line or I will say there is a typo on page H 63 of Appendix H where cooling cost not winter cost in the summer.

Representative Allen: What parts of our state have urban forests. Chris: we don't have an actual number for what you would call urban forests. We can tell you pretty clearly what the forestland cover of the state is. How that intersects with what you would call urban because urban forests can be not only be a tree cover around a house, but a park, a lot of urban parks can qualify as forested. Speaker not identified: One of the things this recommendation makes me think of is there are a lot of community based organizations in NC assessing solar resource in the residential sector for the use of solar power. While it is a great thing to be planting more trees, there seems to be there could be a refinement of this recommendation you don't absolutely have to plant three more trees on a property where it is going to eliminate your ability to use solar hot water and solar electric, If this recommendation could be cognizant of that and try to recommend a balanced approach so that a very concerned land owner could utilize both solutions.

Paul asked for any additional questions or comments on AFW 13 being none Tom closed the discussion.

Tom: In conclusion, I would just add that kind of more broadly a reminder that the numbers that you see on the screen in front of you- these are what we call stand alone numbers or the reduction potential on the costs of cost savings per ton of individual actions but when they're combined together not only within this work group area but with other sectors such as transportation, power generation etc. We pulled together agric numbers in terms of greenhouse emission potential and agric cost effectiveness for all of the CAPAG actions combined. It's significant because there are many integrated and interactive effects between the options, some of them were quite deliberate, others were not but have to be recognized quantatively in terms of deliberated integration. There are a number of measures that are (un audible) contain both supply side and demand side approaches that sit in different places, for instance, we see biofuels supply side issues residing here in Ag. Forestry and waste and the demand issues typically residing in transportation and land use but it is anticipated that the implementation of an overall plan would glue these together. There is a three components of that which would be to even bring additional flexibility to that which could be related to their marked base systems or measurement systems that insure crediting, etc.- that's picked up by the cross cutting issues work group. So I think while we're presenting these one by one and presenting just this work group it should be recognized this is a part of a larger integrated whole that came out of the process. The other point, just a reminder Chairman Garrou in response just to reinterate the point you made earlier- the numbers that we have up here in terms of the cost or cost savings are really the direct costs of implementation of this particular action. They don't include actuary benefits or costs to certainly the issue Co benefits is a significant one in many areas and that's documented elsewhere. These numbers also do not include thee secondary economic impact in terms of jobs, value added income that is the subject of the Appalachian State University study that's going on right now. That is additional secondary information that's not on the chart

Chairwoman Harrison: At this point we would like to take any additional comments and input from the commission.

Jane Preyer: Two things pop up to me today. After hearing all the comments today, one is what George Everette said at looking closely at the cost effectiveness combined with the green house reductions per time and combining those big boosts. Second one is some of the carbon offsets per discussion we heard and the opportunities potential the position NC to be more ready for this or to get in lead on this and get out front. So I would throw out that those are potentially two criteria to think about set of recommendations and the next step somehow getting more specific about some proposals that might feed on those criteria some way.

Dr. Smith: I agree with that. Is there a way just a way just looking at the way CCS has come up with their cost effectiveness? Some of the things that were presented here earlier about the offsets – is there a net present value type calculation that can actually be brought into the overall equation here so we can try to compare apples to apples and then someway – Has that already been done? Will you give us a sense of that or I think if we add that in, which I would encourage that we certainly take a look at, I think a lot of benefits would be interesting to do that.

Steve Roe: Just to underscore that the cost effectiveness numbers that we produced which are essentially direct costs per cost savings per ton are not necessarily the same as the transaction costs that might occur in the market, either for an offset or for a tradable credit because other things go into the termination of that price set up. Actually scrub it down to an offset price would take a little bit more analysis, but I think what you see is one of the most important inputs to that which is cost per across the series to get the marginal abatement actions.

Dr. Smith: Well I guess the question I have is do we want to try to have a discussion here about some agreed upon methodology prioritizing this? Because I think the other overlay to just be very frank about is you've got greenhouse gas reduction cost effectiveness and than you have this sort of politically reality constrained and I think those all have to be sort of factored in here if we're looking at how we take these from the paper and the process we've gone through to where they get in some from of implementation. So it would be interesting to have a discussion with it about how to prioritize these in some way and see if we can get some general agreement from the various members here about how we might do that and what that might look like.

Chairwoman Harrison: I think it's entirely pertinent that we have that discussion today. Do you have some input?

Paul Sherman: Just wanted to add a little bit of background as to what the Farm Bureau has been doing outside this process. We have had several state holder group meetings with various organizations and it sort of led us down the road of organizing several carbon trading work shops that we are going to have actually next week. To do some of the things that are recommended here mainly is the education piece is bringing in land owners whether it be farm or forest as well as co-operative extension in soil and water conservation, district folks, NRCS, educating them about what carbon credit or what carbon credit trading is, how it all comes about and even bring in currently one and maybe in the future multiple variations of the voluntary trading markets that are out there and ways that they can participate in those markets. And sort of something in the back of our mind is part of this process is we can certainly look at what's been done here in the CAPAG . But there are ways that some of the costs of these, some of this education is a whole lot lower cost as far as participating in markets that are already out there that you and see the benefits expect mental to the cost. As far as just helping to promote those types of things that steer up toward a goal without being too terribly forceful about it. With the mechanisms we have out there and then with the Federal mechanisms that are likely down the road.

Mr. Tobin: Madam Chair these recommendations have been developed over the last couple of years by a broad state holder group represented within the CAPAG. And It seems to me that given the presentation of those results the analysi8s that's been done on those items and relative lack of objection to the items that were presented today that we might be at a point where a motion could be made to have the commission adopt these recommendation and to begin the process of developing these items either individually or in some into a bill and it seems that we've got at least four other presentations of items of a similar complexity. And Those, I think it was hoped this is a point of order that Mr. Givens can clarify that some of those might be developed for 2008 session. And it looks to me like with maybe one or two exceptions on this list there is some consensus here that we have a good starting point from which to develop some legislation that could be considered by the General Assembly. So I would just submit that if the time is right, then perhaps a motion could be made and again Mr. Givens could (in audible) if this the time but to go ahead and see if the commission is ready to accept these recommendations made by the CAPAG. Several of whom are serving in both committees but to go ahead and get to the next stage which is a drafting stage where these specific points can be aired for a broader audience.

Chairwoman Harrison: Thank you. I'm going let Mr. Givens have first crack.

George Givens: Well let me at some risk, I will observe that the consensus in this or consensus within the CAPAG is not necessarily translated to consensus across the street or in this room which is populated by the Finance Committee, The Appropriations Committee, or whatever. I think that, well let me say this, I purposely didn't orchestrate some particular outcome to this meeting because I wanted to give you all an opportunity to discuss and how this would go. As a practical matter, I can tell you that (in audible) bills to implement all 54 or 157, whatever the number is, we just don't have the resources to do that and the

General Assembly s0 not have the resources, in time, I think particularly in the Short Session to give all those adequate consideration. Therefore I would encourage you to take observations that Mr. Everett has on cost effectiveness and then factor in there some estimation for reality and we as a staff would like to work on the ones that it appears have the best chance of going forward in 08. Now I would observe to you the following factors, you've got the LCAPAG recommendations as somebody just pointed out and saw some of this in the discussion of we had in February leading up to the Long Session. The recommendations in the CAPAG report are not the be all and end all. There are other ideas that people have that can be looked at. In addition to those issues there's the adaptation issue we're going to begin the discussion of that at the January meeting. There is the question of the goal and that question of the goal really, I thought we would, it was my intention that we have more discussion on that issue at this time. The fact that we haven't is our fault and we will try to remedy that next time. I don't start with presumption; the legislation doesn't start with a presumption that there should be a goal. It says we need to figure that out, but a goal is a guide to how you choose which of these measures you want to pursue. Beyond that there is the question, at least in my mind that the future of this commission is presently set to sunset. When I say this I don't mean this particular this group is appointed constituted but whether we do about Climate Change going forward, what we do about adaptation, what we do about additional mitigation measure. I have some ideas about that as I suspect many of you have some ideas about that. So I think at this point, probably what I would like to hear is if there's further discussion on these proposals in light of what might actually be politically do-able, one of the good features of this commission is that we have a broad in put from outside the legislature that comes at the expense of the fact that you have relatively few people like Senator Albertson, Representative Underhill and Representative Harrison who would have paid to get these bill shepherded through. I can tell you it's from my own experience of 20 some years in looking at the effort that went into Senate Bill e is controversial (in audible) effort hard for it to get one item through the Legislature. And so that's my gloss on it, in other words, I think to answer your question directly a motion to go out and do good, however commendable , is not particularly helpful at this point. We need something a little more surgical, and if we're not prepared to do that today then we need to figure out how we're going to get there. And I'm prepared to help you do that.

Mr. Garrou: One of the things that I think this commission needs to decide and this is a political question, I'm not sure in the Legislature so I don't know how to answer it. Do we really want to recommend 54 things or do we want recommend 3 things, 5 things? So I would suggest that we don't want to adopt all these things today, but we want to wait until we see the whole package and then say do we really want to recommend all these things or do we want to push a half a dozen of them.

Harrison: And I can just add to that when we issue our report we can still contain these recommendations and then we'll have specific goal proposals as well. So its not that these recommendations will be left out, if that helps at all.

Mr. Slocum: Yes, I think the (in audible) of Mr. Givens is well taken and when I look at the recommendations that are made in this group and are made in this section and then how do you get there now there are a few things that come to mind. Almost every one of them is a money issue that actually makes it happen and there are a couple established programs that really touch on or would get at several of these. The Agriculture and Farmland Preservation and Trust Fund gets some of this. The existing car share programs for forest and agriculture get at a large part of this. We've got Senate Bill 3 created a center for biofuels in NC which really gets at the biofuels section, so there may be some specific things that can be recommended that w3ould get us toward a large range of large number of these but it's a small number. The reality of how much more money is available. I leave that to the astute guidance of Senator Albertson, the chair, and Representative Underhill; but unfortunately to get to where we want to go or where this report recommends, It's a money issue to a large degree and now where the money is going to come from.

Co-Chair Harrison: Thank you. Mr. Profeta

Mr. Profeta: Thank you madam chairman. I would agree with the comments of many of you in terms of trying to prioritize these recommendations. I think we've heard from George Everett we need to create some const effectiveness, bang for the buck criteria by which we are (inaudible). We want to ask for the chart and you certainly in ranking (in audible) I would say to Bob the reason I thought we might be able to pick up the three pieces that were in the McDowell testimony and because that's one way to facilitate some money not from the State but from private investment stream. And I think we seem to be fertile ground for that sort of investment and we probably should encourage to act fast, and encourage the investment stream to come. So when I hear Paul Sherman talking about we need more education for landowners – that's a piece of it, and when I hear Representative Thomas talk about we need a single standard that's a part of it. NC is on the board of the 40 State Climate Registry could advocate for one national standard on these offsets that would promote investment so I would suggest to the commission informally, not procedurally, is that we somehow ask for a cost effectiveness evaluation of CAPAG recommendations but also consider a package just to create the fertile investment environment and off sets.

Dr. Crawford: I do want to clarify my position. What I'm really much more interested in is that column which – what is the actual savings in CO 2 and what worries me about (inaudible) of this that having 50 recommendations is that each recommendation requires a champion that has to use their personal energy in chits and so forth to move things forward and I just think if we have a large number of these things each with small impact there's too much of a chance that at the end of the day a few of them go through and you end up with 8% drop in CO 2. I'd rather see bogus effort of a numbered people around e or 4 really big issues where at the end of the day we say boy did we make a big drop in the CO w emissions for the State

Mr. Urlaub: Thank you, following up on Douglas Brown's and George Everett's comments what I'm thinking is – could we have some kind of one pager that maps out the inner relationship of across the five sector groups. There was mention of several of these agriculture, forestry and waste management options that they're incremental above and beyond one or more other options and other categories and if we could have maps or word piece options where these options do naturally group together and where they're incremental to each other then we could maybe start to see a bigger picture where there's several options across sectors that could formulate into one agri-gret recommendation or policy action.

George Givens: I see Mr. Peterson nodding his head and I think that would be useful in a number of ways when you're looking at cost and cost benefits to get some across the board comparisons as opposed to just within individual sectors.

Tom Peterson: If I might just elaborate, it's fairly typical as a follow up phrase to the more detail line item planning recommendations to bundle actions phanatically or bundle them in a way that makes sense functionally in terms of implementation. So it would be very reasonable to expect that in terms of implementation, packages a list of 150 some will shrink (in audible) 10 or less in terms of structuring implementation programs and I would certainly anticipate that that's something that could be done as a next step here to integrate just as you suggest . The other thing I would just note is with respect to the cost effectiveness numbers, it will probably not be too long before we could add to these direct cost numbers the results of the Appalachian State Study which would indicate the potential benefits these actions might have in terms of jobs, income in value added that could be considered as a part of quote unquote "band for the buck" calculation so is the commission would be interested in seeing those results added to have a bit broader picture in terms of economic opportunity that could be done as well.

Harrison: I think we would, I think that we would appreciate that. Thank You.

Dr. Eggers: Because we're having this discussion it seems like we're starting to kind of identify more of a triple bottom line issue that it's not just simple economic analyses, we have not simple in terms of effort but we need additional economic information and then major social impact that'll happen because of jobs and the major social impacts that will happen because of quality of life issues that will be affected by this for future generation and environmental impacts and so I would encourage us to because of the profound ethical obligation of this commission to consider all three of those bottom lines.

Harrison: Thank for that point.

Dr. Everett: Tom, I know that the draft final report says do note quote or cite. But we've all at least a large portion of us have seen it and in that at least in my October 16th version, I don't know which version we're on. There is a ranking that you've already done which would be helpful. I think to everybody when you're at a point when you're ready to share it. And the good news I would say about that ranking is in terms of reductions of emissions the number one item by far in the graph is done. So feel good about where we are. The next item on the list achieves about half of what item one does in terms of reduction of emissions and in terms the next table which is figure 1-4, it is I think very instructive to look over there on the far right hand side of that chart which is a ranking of dollars by ton and you'll see maybe where you can quickly begin to not worry about some of these items and they'll fall off pretty quickly so I think it does bring value to look at the whole set land not to take one of these working groups and do the whole package. We ought to selectively go through them just like this has attempted to do and it's very helpful to look at those charts. They're not definitive by themselves but they're helpful.

Dr. Smith: Well I don't disagree with that at all, I think ;that if we were, We should reach, I guess, some sort of agreement about how we want to go forward on this and what are going to be the methodologies if we're going to attempt to rank them try to drill down some very specific items. I do want to caution, although. I'm very aware of the political realities of the cost of going forward. I want people to remember because we haven't engaged in this discussion at the level that I think ultimately we're going to need to engage in it but there is a cost in-action and I think people have got to constantly remember that when we get into the adaptation and some of the things that the State is facing and some of the things, it's very easy to immediately look at the cost that you're dealing with and real time but I have to think we don't have, I think, fully the understanding of all the potential costs of in-action which may be able to shift that the political possibility equation. When we begin to really look at some of the costs that NC is going to surely incur from the need for adaptation and some of the things are in motion. So I just and I don't know how we are going to qualify that, and bring that in ultimately, but I think it's got to be part of overall calculus here because the financial political realities we are in today are not going be the same that we're going to be in the not too distant future. As these manifestations continue to unfold and for those of us who are dealing with issues like drought, this past year and other things like that and see some of the emerging issues that continue to sort of come at us very rapidly, I think it would be a mistake to only be looking at it in the context of sort of a politically reality and financial reality today because doing nothing on some of these issues is not an option. We're going end up paying one way or the other.

Co Chair Harrison: Very good point, thank you for that. Anybody else? I guess if there's nobody else who has anything to say, we'll adjourn. Thank you all for coming and our next----Mr. Profeta.

Tim Profeta: I'm sorry Madam Chair. Are there any other analyses like that George has describes that would be useful for our assessments. I think we should ask that question or I can just leave the question

out there to be banged around with staff, but I, it strikes me if that analyses exists, I would like to see it and any similar, I would like to see them as will.

Harrison: And that analyses he references is in the summary document that we got last time and is on page I.17 summary to the CAPAG and we will redistribute that.

Profeta: Well I have that. So maybe the answer is no there are no others.

Harrison: But I will let Mr.Givens respond in more detail.

George Givens: Well what I was going to do is follow what Doug Brown said about the companions and the fact or the matter is that there are only some number of people to handle the bill regardless of how many recommendations you've got. And it would service commission's legacy well to propose six and get five than to propose 57 and get 4. What I think what we'll do is have some further discussion off line in addition to all the criteria that have been mentioned, the ones Dr. Everett and Dr. Eggers mentioned the political realities. I value most highly those suggestions that meet all those criteria and that there's always some draft legislation to use as a guide and we'll be looking for those and for those of you who have good samples that you've acquired from some place or other, we should be happy to have staff to see those and we'll be talking with many of you off line as to how to resolve the questions and issues we've raised today.

Harrison: Any thing else? I hope on the addition adaptation, if we bring up any of these other subject areas we're discussing, we will let you know in enough time so that you can review your document that we got at the last meeting or get the section out to you. So I guess with no further business, we'll adjourn. Thank you all for coming.

Respectfully Submitted

Representative Pricey Harrison, Co-Chair, Presiding

Mr. John Garrou, Co-Chair

Minutes by Anne Misenheimer

APPENDICES

Exhibit A	Visitor Registration
Exhibit B	Agenda
Exhibit C	William C. McDow III
Exhibit D	Bill Chameides
Exhibit E	The Center for Climate Strategies
Exhibit F	DAQ Suggestions for Course of Action on CAPAG AFW Recommendations
Exhibit G	Climate Action Plan Advisory Group
Exhibit H	A Legislative Proposal to Prepare NC's Agriculture & Forestry Sectors for Emerging Carbon Marketplace
Exhibit I	Climate Action, Forestry, and Waste Technical Working Group (Appendix H)
Exhibit J	Chapter 6 Agriculture, Forestry, land Waste Management
Exhibit K	Climate Action Plan Advisory Group, Chapter 6 Controlling Greenhouse Gas Emissions

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Legislative Commission on Global Climate Change

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AGENDA

10:00 a.m. Tuesday 4 December 2007
Room 643 Legislative Office Building

1. Call to order
   Representative Pricey Harrison

2. Introductory remarks by Cochairs
   Representative Pricey Harrison
   John. L. W. Garrou

3. Report to the Commission and explanation of agenda items
   George F. Givens, Commission Counsel

4. Update on federal activities related to global climate change
   Timothy Profeta, Director
   Nicholas Institute for Environmental Policy Solutions, Duke University

5. Discussion of the extent to which carbon offsets may be reliably identified and quantified
   William L. Chameides, Dean
   Nicholas School of the Environment, Duke University

6. Discussion of opportunities for, and recommendations related to, carbon offset projects in the agriculture and forestry sectors
   William C. McDow III, Southern Forest Projects Manager
   Environmental Defense

7. Presentation and consideration of the recommendations of the Agriculture, Forestry, and Waste Technical Working Group of the Climate Action Plan Advisory Group (CAPAG)
   Brock M. Nicholson, Deputy Director
   Division of Air Quality, Department of Environment and Natural Resources (DENR)

   Thomas D. Peterson, President and CEO
   Center for Climate Strategies

Stephen Roe, Senior Scientist
E.H. Pechan and Associates and Facilitator
Agriculture, Forestry, and Waste Management Technical Work Group and
Lead Consultant for Emissions Inventory, Center for Climate Strategies

Dennis W. Hazel, Assistant Professor and Extension Specialist
Department of Forestry and Environmental Resources, NCSU

Christopher B. Hopkins, Outreach Associate
Department of Forestry and Environmental Resources NCSU

M. Paul Sherman, Director of Air Quality and Energy Programs
North Carolina Farm Bureau Federation

Robert W. Slocum, Jr., Executive Vice President
North Carolina Forestry Association

8. Commission discussion of recommendations.

9. Adjourn

SCHEDULE OF FUTURE MEETINGS:
The Cochairs and Counsel have established the following schedule of meetings of the Legislative Commission on Global Climate Change for the 2007-2008 Legislative Interim. Except as noted, all meetings are scheduled for 10:00 a.m. This schedule is subject to revision. ***Revisions made since the October meeting are shown in italics.***

Commission Meeting	**Location**
Wednesday 16 January 2008	643 Legislative Office Building
Monday 11 February 2008 – Emerging Issues Forum*	*McKimmon Center, NCSU*
**** Business Meeting 2:30 p.m. to 3:45 p.m.***	***Room 2, McKimmon Center, NCSU***
Tuesday 12 February 2008 – Emerging Issues Forum	*McKimmon Center, NCSU*
Wednesday 5 March 2008	643 Legislative Office Building
Wednesday 16 April 2008	643 Legislative Office Building
Wednesday 7 May 2008	*544 Legislative Office Building*

COMMISSION WEBSITE:
In order to provide public access to the materials distributed at the meetings of the Commission and to other documents related to the Commission, a website has been developed for the Commission. The website can be viewed online at the following address:

http://www.ncleg.net/gascripts/Committees/Committees.asp?sAction=ViewCommittee&sActionDetails=Non-Standing_6268

ADDITIONAL INFORMATION:
Persons having questions about the Commission meeting or other matters related to the Commission may contact Commission Counsel or other Commission staff at (919) 733-2578.



The Center for Climate Strategies

Helping States and the Nation Tackle Climate Change

www.climatestrategies.us

Memo

To:	John Garrou, Chair, Representative Pricey Harrison, Co Chair, and George Givens, Counsel to the North Carolina Legislative Commission on Global Climate Change
From:	The Center for Climate Strategies
CC:	North Carolina Department of Environment and Natural Resources
Subject:	Center for Climate Strategies Technical and Economic Qualifications
Date:	December 3, 2007

At the last meeting of the North Carolina Legislative Commission on Global Climate Change (LCGCC), a question was raised regarding technical qualifications and procedures of The Center for Climate Strategies (CCS) as they relate to economic analysis of proposed climate mitigation policy actions. For the benefit of the LCGCC, we have attached credentials of some of the key personnel at CCS involved in economic assessments for its projects, and a note regarding quantification procedures (below). The attached technical qualifications include members of CCS with appointments or degrees in economics, but do not include additional, highly credentialed members of the CCS team involved in interdisciplinary assessments typically related to economic performance evaluations (CCS has over 25 staff consultants with expertise in disciplines such as law, business, engineering, resource management, mathematics, science and other issue areas).

The procedures used by CCS to develop final economic analyses that support facilitated advisory group decisions (such as those of the North Carolina Climate Action Advisory Panel, or CAPAG) involve formal decision-making by advisory group members. These are conducted through a stepwise fact finding and joint decision-making process designed to build consensus and resolve conflicts associated with specific proposed mitigation actions through the process of collaboration. Decisions regarding the final analysis of draft proposed actions -- including specific data sources, methods and assumptions for the analysis of each -- are made by members of the advisory group (CAPAG members) as a part of the consideration of final recommendations. CCS provides impartial facilitative and technical assistance to support these decisions.

Advisory group representatives are appointed by the convening authority; in the case of the CAPAG process, appointments of CAPAG and technical work group members were made by the North Carolina Department of Environment and Natural Resources (DENR).

The procedures of the CAPAG process are documented through its proceedings and final report, and can be found on the project website at www.ncclimatechange.us. Quantification procedures for the CAPAG process included initial guidance from standard federal guidelines for preparing economic analysis provided by the U.S. Environmental Protection Agency that can be found at: http://yosemite.epa.gov/ee/epa/eed.nsf/webpages/Guidelines.html, In addition, a special quantification memo was provided by CCS to CAPAG members and technical work group members to support decisions on the design of technical analysis of proposed greenhouse gas mitigation actions and can be found at: http://www.ncclimatechange.us/ewebeditpro/items/O120F8528.pdf. Model Codes of Conduct that guide CCS facilitators and technical consultants can be found at: http://www.climatestrategies.us/code_of_conduct.cfm.

The final, specific elements of economic analysis and other quantification of individual proposed CAPAG mitigation actions were determined by CAPAG members and are customized for each proposed action. These final results are based on consideration of many issues discussed during the collaborative process and, as a consequence, may to some extent vary from initial standard approaches. Results of these analyses can be found in the detailed appendices to the final report at: http://www.ncclimatechange.us/capag.cfm.

Credentials of current, key personnel of CCS regarding economic analysis include:

Thomas D. Peterson, President and CEO, The Center for Climate Strategies

- Tom Peterson founded CCS to assist governments and their stakeholders with planning, policy development, consensus building, and conflict resolution for climate change and energy policy. In addition to an accomplished career as an economist with the U.S. Environmental Protection Agency, Tom is an adjunct law professor at Pennsylvania State University, where he teaches Climate Law and Policy in the graduate schools of Law, Forestry, and Geography. His credentials include:
- Economist for 10 years (1991-2001), United States Environmental Protection Agency (U.S. EPA), assigned to the Office of Policy Planning and Evaluation, the U.S. Senate (Brookings Legislative Fellow), the White House Climate Change Task Force, the Office of Air and Atmospheric Programs, and the Office of Transportation and Air Quality.
- Two Gold Medals for Exceptional Service from the U.S. EPA
- M.E.M., Duke University (concentration in natural resource economics and policy)
- M.B.A., University of Texas at Austin
- B.S. College of William and Mary (Biology, concentration in economics)

Dr. Adam Rose, Professor, University of Southern California, Acting Director, Energy Institute (EI) Coordinator for Economics, Center for Risk and Economic Analysis of Terrorism Events (CREATE), Research Professor, School of Policy, Planning, and Development (SPPD), Senior CCS Advisor and Consultant

- Dr. Rose is an internationally recognized researcher and policy advisor on macroeconomic modeling of climate, energy, and equity issues. His research focus is environmental & resource economics, energy economics, regional & urban economics, natural hazards, economic development, and applied general equilibrium analysis. His credentials include:
- Professor and Head of the Department of Energy, Environmental, and Mineral Economics at Penn State University from 1988-2002
- Ph.D. in Economics, Cornell University

- M.A. in Economics, Cornell University
- B.A. in Economics, University of Utah

Dr. Peter J. Kuch, Senior CCS Advisor and Consultant

- Peter J. Kuch is a consulting agricultural/resource economist with over 27 years of experience at working on economic incentive strategies, sustainable agriculture and non-point source pollution issues, natural resource conservation, and climate change policies. His credentials include:
- Director, Natural Resource Sectors Program, Office of Policy Analysis, U.S. EPA Office of Policy Planning and Evaluation,1995-1999
- Chief, Agricultural Policy Branch, Water and Agricultural Policy Division, U.S. EPA Office of Policy Planning and Evaluation, 1991-1995
- Ph.D., Economics, University of Minnesota
- M.A., Economics, Syracuse University's Maxwell School in Economics and Public Administration
- A.B., Cornell University in Economics

Dr. Lewison Lem, Principal Consultant, PB and CCS Senior Transportation and Land Use Facilitator and Consultant

- Dr. Lem is a nationally recognized expert on transportation, public finance, and economics; interactions between transportation, energy, and the environment; and relationships between travel, land use, and air quality. His credentials include:
- Principal Consultant, PB (formerly Parsons Brinckerhoff) an internationally known consulting firm active in multiple market sectors, including transportation, power, buildings/facilities, water/wastewater, environmental, and urban/community development. Dr. Lem leads the national Transportation Energy and Climate Change consulting practice area and is a contributor to the Economics consulting practice area for PB
- Transportation Economist, U.S. EPA
- Transportation Economist, U.S. Congress' General Accounting Office
- Graduate Affiliate Faculty, Public Policy Center, University of Hawaii; previously visiting scholar, University of California Transportation Center (UCTC) (UC Berkeley) and the University of California, Los Angeles (UCLA) Institute of Transportation Studies
- Ph.D. in Urban Planning and Public Policy, University of California-Los Angeles
- M.A., Public Policy and Administration, Columbia University
- B.A. in Government, Harvard University

William Schroeer, Vice President, ICF International, Senior CCS Transportation and Land Use Facilitator and Consultant

- Mr. Schroeer has more than 16 years experience designing and directing transportation and land use policy evaluations for government, nonprofit, and private clients; examining costs and benefits, feasibility, economic, social, and distributional impacts. Before consulting, Mr. Schroeer was at the U.S. EPA, in the Office of Policy, Planning, and Evaluation, where he led the agency's Transportation Group. His credentials include:
- Economist, U.S. EPA
- National Planning Award from the American Planning Association
- 2 EPA Service Awards
- B.A. *magna cum laude,* Carleton College

- Master of Public Policy, Harvard University

Alice Napoleon, Synapse Energy Economics. CCS Residential, Commercial, Industrial Technical Work Group Facilitator and Consultant

- In her work at Synapse Energy Economics, Alice Napoleon conducts economic and policy analysis of electric system and emissions regulations. Her recent projects include researching policies and trends that affect PM2.5 ambient concentrations, analyzing economic drivers of electric system emissions of primary and secondary PM, and proposing policies for mitigating these emissions in and around New York City. She recently conducted a sweeping review of emissions allowance markets, models, and projections; and, economic and policy developments that affect these markets. Her credentials include:
- MPA, Public Administration from the University of Massachusetts at Amherst
- BA, Economics, Rutgers University

Joseph Pryor, Project Manager, E.H. Pechan & Associates, Inc. Agriculture, Forestry, and Waster Technical Working Group Co-Facilitator and Consultant

- Joseph Pryor provides facilitation and technical support of greenhouse gas mitigation analyses in a variety of economic sectors for CCS. His credentials include:
- Senior Policy Analyst (2003-2006), Australian Greenhouse Office (AGO), Australian Government. His credentials include:
- BSc, Forestry, Australian National University (2001)
- BEc, Economics, Australian National University (2001)
- Grad Diploma, Post-Graduate Diploma of Applied Finance and Investment, Financial Services Institute of Australasia (2005)

Discussion of Opportunities and Recommendations for Carbon Offset Projects in North Carolina's Agriculture and Forestry Sectors

William C. McDow III
Southern Forest Projects Manager
Environmental Defense
December 4, 2007

Good morning. Thank you very much for the opportunity to speak to the Global Warming Commission today. My name is Will McDow. I serve as the Southern Forest Projects Manager for Environmental Defense. Environmental Defense is a national nonprofit organization committed to finding economically viable solutions to some of our most serious environmental problems. A large part of my job entails identifying sound incentive mechanisms that will spur environmentally beneficial practices on forest and agricultural lands here in North Carolina and across the Southeast, some of which involve actions to avoid, curb or sequester greenhouse gas emissions.

My comments today will focus specifically on the enormous opportunity carbon offsets could provide the agriculture and forestry sectors in North Carolina. Carbon offset projects essentially are actions that individuals such as farmers and landowners take to avoid greenhouse gas emissions or sequester greenhouse gases. If done properly, these actions can produce high-quality, verifiable greenhouse reductions or credits that can be sold to a variety of entities in what is called a carbon market. While I cannot stress enough that carbon offset projects would be worthwhile merely for their potential to produce immediate greenhouse gas emission reductions, my comments today will focus on the tremendous economic benefits that they offer and the need for the state to help prepare landowners and farmers especially to participate in the emerging carbon offset market.

The state can help facilitate the emergence of agricultural and forestry carbon offset projects by:

(1) Educating farmers and landowners on the emerging carbon offset market – first and foremost so that they undertake activities that produce the highest-quality, most economically competitive offsets. These will be offsets or credits that produce measurable, verifiable and accurate reductions in greenhouse gas emissions. Education will help farmers and landowners know how to seize these opportunities and with whom to partner. Finally, education will help landowners structure projects to protect their interests, financial and otherwise;

(2) Establishing guidance on what makes a truly effective and financially viable carbon offset project. The Duke Standard serves as a very good resource for that guidance; and

(3) Generally promoting high-quality, verifiable carbon offset projects and helping them to get underway as quickly as possible.

Before delving into these specific topics, I would like to provide you with an idea of the projects and work that we at Environmental Defense are already witnessing. I imagine that there are many other projects underway of which we are not yet aware. In addition, I would like to mention that the state's actions to spur carbon offset projects will help to

lay the foundation for some of the recommendations from the CAPAG on agricultural and forestry practices to reduce greenhouse gas emissions. Essentially, carbon offset projects serve as one of the major financial mechanisms by which these activities can be put on the ground.

I. Opportunities – The Interest is Here Already

If I can leave you with one impression today, it is to tell you that our state possesses great potential to generate carbon offsets and that the interest is already strong in investing in these projects in North Carolina. First, let me describe the types of projects that are available to investors in our state. There are a large variety of projects that could qualify.

For example, offsets could be produced by:

- Capturing methane (a potent greenhouse gas) from animal waste and converting it to renewable energy or avoiding methane production in the first place;

- Implementing soil and water conservation best management practices, which include but are not limited to precision application of nitrogen fertilizer, conservation no-till, riparian buffer restoration, and conversion of marginal or highly erodible lands to forests; and

- Sequestering carbon in forest stands and soils through better management practices. This especially is a good option for providing landowners with an added revenue stream so as to withstand development pressure.

Clearly, North Carolina is fertile ground for many of these projects, and the state has caught the attention of many interested parties from within and outside the state. At Environmental Defense, we have seen a steady stream of investors over the past year that have asked our office how to undertake greenhouse gas offset projects in the state. In particular, legislation passed in the 2007 session that established a cost-share program to promote the adoption of innovative hog waste management systems and the renewable energy and energy efficiency portfolio standard have shown investors that there are already resources and a concerted drive to reduce greenhouse gas emissions in the state.

(1) SB 1465: The lagoon conversion cost-share program that passed as part of comprehensive swine farm legislation this year has put our state on the map as the leader in animal waste management innovation. That innovation will pave the way for carbon reductions, and investors view our state as the proving ground.
(2) SB 3: The Renewable Energy and Energy Efficiency Standard (REPS) has also sent a strong signal to investors that the state is serious about identifying alternatives to coal that will reduce greenhouse gas emissions into the atmosphere. Those avoided emissions could be an added source of revenue for farmers and forest land owners, and make the economics work for waste-to-energy.

Because of the focus on swine in our state and in these two specific pieces of legislation, the main thrust of early carbon offset project interest in North Carolina has been in the swine sector. Projects that involve forest management and agricultural best practices are gaining momentum as well. Emerging carbon offset opportunities include:

1. EcoSecurities – EcoSecurities is a multi-national company that develops and supplies emission reductions for both the compliance and voluntary markets. The company's interest in North Carolina stems directly from the establishment of the lagoon conversion program in the swine legislation passed in 2007. EcoSecurities is looking now to working with individual swine producers to develop lagoon cover and anaerobic digestion projects that will produce verified emission reduction credits that can be sold to a number of entities.

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These examples underscore how the state is attracting investors that have substantial capital and interest in generating carbon offsets for both the compliance and voluntary markets.

II. Creating High-Quality Carbon Offset Projects

Not all carbon offset projects are created equally. The marketplace rewards high-quality projects with higher prices and lower quality with lower prices. As the new carbon market emerges, landowners are often approached by companies they do not know and offered financial returns for a "product" they do not fully understand. High-quality offset

projects achieve meaningful carbon reductions, adhere to transparent, credible standards, utilize a verifiable baseline and measurable accounting metrics. The state should promote strong standards so that market participants are all operating by the same game book. The Duke Standard[1] provides an excellent roadmap for how to measure and verify projects.

III. Recommendations

North Carolina certainly is waking up to the opportunity of the carbon offsets market. However, the state could be moving much more quickly and strategically to fully grasp this potential. For example, staff from the U.S. Environmental Protection Agency's Region 4 Office in collaboration with the North Carolina Farm Bureau has been hosting informational meetings on carbon credit trading. Representatives from state and federal government, including officials from USDA's Natural Resources Conservation Service, our local academic institutions, and non-governmental organizations and industry associations have been meeting to ascertain how carbon credit trading works and what steps are needed to develop projects. A smaller group of forestry interests is coming together to discuss forest carbon offset projects in the Southeast.

While everyone is excited about the promise of carbon offset projects, most are waiting for a clear signal of how exactly to proceed. In order to move ahead, Environmental Defense recommends that the state move quickly to address three specific needs: (1) the education of landowners who are eligible to engage in carbon offset projects; (2) the creation of clear and uniform guidance for carbon offset projects; and (3) lowering of the transaction costs inherent in any offset project.

1. **Education of Farmers and Landowners.** There is certainly much to learn to take advantage of these new opportunities. With technical assistance and education, however, farmers and landowners can be prepared to seize the opportunity. Technical assistance and education could occur through extension service to ensure that landowners and farmers (a) understand the opportunities and what projects would qualify, and (b) are equipped with the knowledge needed to ensure that they can fairly negotiate a fair shake. This could occur specifically by increasing knowledge of farmers and landowners by directing those with whom they interact, such as the Cooperative Extension Service, the Division of Soil and Water Conservation, the Division of Forest Resources, the Rural Economic Development Center, and USDA representatives.

2. Establishment of Guidance to Develop Clear and Uniform Standards. Carbon offset projects must achieve real, meaningful carbon reductions – to make a difference for the environment and to be of value in the emerging carbon marketplace. Standards are needed so that investors and landowners understand exactly what they are getting and what is required of them. The monetary value of offsets depends on whether they meet high quality standards and create a verifiable net reduction of greenhouse gases in the atmosphere. Some steps the state could take include:

a. Development and Adoption of Standards – The state should develop and adopt standards for agriculture and forestry emission reductions and offsets. Clear

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guidance from the state will assist farmers and landowners who undertake carbon offset projects to know what counts and is marketable. The Duke Standard serves as an excellent starting point. Standards could be established through North Carolina's involvement in the multi-state Climate Registry. Any standards or guidance should require the following:

i. Offset projects must exceed business as usual and not cause greenhouse gas emissions at some other juncture (i.e., additionality and leakage);

ii. Methods and assumptions used to calculate and verify emissions reductions must be transparent and independently verifiable. The verifying body or entity must have no financial interest in the project, and projects should be subject to ongoing quality assurance and quality control assessment (i.e., Third Party Verification);

iii. Offsets must be maintained. Some accounting mechanism must be established to track changes in the quantity and ownership of the reductions. Moreover, the timeframe in which the emission reductions are expected to be achieved should be clearly identified. Any potential future releases should be anticipated and mitigated, possibly through replacement reserves or other insurance mechanism (i.e., permanence); and

iv. A mechanism should be established to ensure that carbon offsets are enforceable. Reductions should be serialized and tracked on a registry to prevent individual emission reductions from being sold repeatedly. Currently, North Carolina is part of the national climate registry. While this can be achieved through the Climate Registry, the state should work to ensure that the registry lives up to these principles;

b. Clarify ownership issues. The state should act to reduce confusion by clarifying that farmers and landowners retain the rights to sell carbon credits when they sell or donate conservation easements for clean water, wildlife, farmland preservation and other purposes (e.g., CREP, CWMTF, ADFPTF). Similarly, clear guidance is needed for agricultural and forestry cost share programs that may lead to carbon sequestration or emission reductions on private property. Many of these state and federal programs have not addressed these ownership issues.

c. Net environmental benefit. The state should clearly endorse the principle that carbon offset projects should always serve as a net benefit to the environment. Every effort should be made to avoid 'unintended consequences'. All carbon offset projects should be designed to address other environmental problems so the project has a net benefit for the environment. For example, with projects that involve waste-to-energy on swine farms, Environmental Defense would like to see that revenue from carbon offsets must be used to offset the costs of full innovative systems that meet all of the environmental performance standards established for new or expanded swine farms. Certainly any projects that receive subsidies, either through cost-share funding or from utility ratepayers, should have to meet environmental performance standards. Some private investors consider this to be absolutely critical.

3. **Reduce Project Costs**. High, upfront transaction costs and delayed income limit the current financial returns of some carbon offset projects. The state could lower measurement, verification and other transaction costs by providing:

a. Third Party Verification and Measurement. The state specifically could serve as a verifier and/or help to measure carbon reductions, which could be a substantial transaction cost for individual farmers and landowners. This also could include some type of mechanism to rate aggregators and project developers so that those that want to undertake projects could have a place to turn for unbiased, sound advice on how to structure offset projects and contracts;

b. Carbon offset economic development and recruitment. The state Department of Commerce should develop an economic development strategy to recruit and aggressively court investors and carbon offset entities to invest in North Carolina.

c. Increase private investment by directing Departments of Agriculture, Commerce and DENR to work with key commodity groups, including swine producers, dairy producers, and forest landowners and carbon aggregators to develop major projects;

d. Reduce the costs of environmentally superior hog waste management processes that capture methane and address other pollution problems and attract additional private investment in improving hog waste management by increasing appropriations to the Division of Soil & Water Conservation's NC Lagoon Conversion Cost Share Program; and

IV. Conclusion

As this Commission turns its attention to specific legislative proposals, it is appropriate that it has started by discussing offsets. The state can quickly and easily facilitate economic investment and address global warming by educating farmers, establishing guidance and promoting carbon offset projects. These projects present the quickest win-win opportunities of the issues that are before you.

The state should be doing all it can to help our forestry and agricultural sectors – including large and small farmers, land holding companies, forest landowners and forestry companies – take advantage of carbon offset projects. Doing so will help some of our most economically strapped areas of the state, will make North Carolina a leader in climate solutions, and will maintain our natural heritage.

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www.ecosecurities.com

November 30, 2007

To: North Carolina Global Warming Commission
From: EcoSecurities, Ltd.

To Whom It May Concern:

EcoSecurities is excited about the opportunity to work with farmers in North Carolina on providing sustainable solutions to animal waste systems. We look forward to the possibility of working with the North Carolina Global Warming Commission on providing opportunities for carbon offset projects to serve swine farms. Enclosed in the memo is information on EcoSecurities, the voluntary carbon market, and project development opportunities in North Carolina.

About EcoSecurities
EcoSecurities is a leading company in the business of sourcing, developing and trading emission reductions worldwide. With over 10 years of experience in the international carbon market, EcoSecurities is a world leader in generating carbon credits from greenhouse gas (GHG) emissions reduction projects. EcoSecurities structures and guides GHG emission reduction projects through the Kyoto Protocol, and in the US voluntary market, working with both project developers and buyers of carbon credits. Also, EcoSecurities boasts a consulting arm that has assisted Fortune 500 companies with carbon market strategy and supply chain analysis. With a network of offices and representatives in over 20 countries on five continents, EcoSecurities has amassed one of the industry's largest and most diversified portfolios of carbon projects. Today, the company is working on 402 projects in 36 countries using 18 different technologies, with the potential to generate more than 142 million carbon credits.

EcoSecurities and North Carolina
The US is a large market for EcoSecurities' project development, and EcoSecurities has global expertise in many sectors, including landfill gas capture and utilization, renewable energy, agricultural and urban waste management, industrial efficiency, and forestry. Within the US, EcoSecurities is interested in working with North Carolina swine producers to develop lagoon cover and anaerobic digestion opportunities. North Carolina, a leading national producer of pork, generally does not have a significant agricultural base to absorb nutrient-laden waste water from swine operations. EcoSecurities can work with farms to provide support for and development of anaerobic digestion projects. These projects would not only provide North Carolina swine producers with valuable income and a hedge against rising energy prices, but they could also provide environmental benefits for the entire state beyond emission reductions.

US Voluntary Market
In the voluntary carbon market, projects that reduce GHG emissions produce Verified Emission Reduction 'credits' (VERs) that can then be sold by project developers to companies, organizations, or individuals who wish to meet their GHG reduction targets for carbon neutrality, corporate social responsibility, or pre-compliance risk management.

As the appetite for VERs has grown, so too have the opportunities for developers of emission reduction projects. Between 2005 and 2006 alone, the voluntary carbon market grew by at least 200%, and all estimates project even greater growth for 2007. New Carbon Finance and Ecosystem Marketplace

estimated the size of the global voluntary market in 2006 to be $91 million.[1] Currently, the US represents over half of the transacted MT CO2e volume, making it a big player in the voluntary carbon market. [2] In the US, waste projects (e.g. agricultural and landfill methane) represent the largest supply of carbon credits and greatest number of voluntary carbon projects.[3] North Carolina's dominance in national pork production makes it an important market for anaerobic digestion carbon offset projects.

Project Development with North Carolina's Swine Farms

EcoSecurities is planning to develop verified emissions reductions (VER) projects that address all five criteria under SB1465. The SB1465 provides options for better electricity prices along with digester funding that will help make projects viable, which could help North Carolina become a leader in making digesters possible. This will allow EcoSecurities to benefit from the funding sources within and outside of North Carolina. We would like to partner with local development groups and continue to work with North Carolina State, Duke University, and University of North Carolina on their research and development. We plan on working with Environmental Defense and other stakeholders to garner their insights and to provide our expertise in carbon offset project development to ensure swine facilities receive the best technology. In working on anaerobic digestion projects in North Carolina, we hope to work with farmers to create additional revenue streams for them in conjunction with providing opportunities to reduce GHG emissions.

Ways to stimulate investment for carbon offset projects

In EcoSecurities' experience, we have seen issues for permitting and federal grant delays. Many grant recipients have seen long delays in receiving the money that have led to inflation and price overruns, making the need for a transparent grant process a must. We would suggest a process that ensured timely distribution of funding to recipients. Additionally, we would suggest the following:

- Programmatic project approach (linking several smaller projects into one big one);
- Using a mix of both grant and private funding (new Lieberman-Warner Bill mark-up removed caveat that it would not accept credits from projects that received federal funding);
- The ability to use energy produced on-site or sell to the grid, which gives the projects a much more favorable payback period , making them more attractive for investment

Carbon Credits and North Carolina's Swine Farms

In the voluntary market, carbon credits are generated by projects that reduce GHG emissions and are referred to as Verified Emission Reductions (VERs). On the project development side, carbon credits help a project reach financial viability and they increase the environmental credibility of the facilities. The financial return from VERs help hedge risks in the development of the projects.

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[1] State of the Voluntary Carbon Market 2007 – Picking up Steam. New Carbon Finance and Ecosystem Marketplace. July 17, 2007
[2] Carbon Market Analyst: Voluntary carbon markets: Lost in transactions? Point Carbon Research. October 24, 2007
[3] Carbon Market Analyst: Voluntary carbon markets: Lost in transactions? Point Carbon Research. October 24, 2007

Discussion of Opportunities and Recommendations for Carbon Offset Projects in North Carolina's Agriculture and Forestry Sectors

William C. McDow III
Southern Forest Projects Manager
Environmental Defense
December 4, 2007

Good morning. Thank you very much for the opportunity to speak to the Global Warming Commission today. My name is Will McDow. I serve as the Southern Forest Projects Manager for Environmental Defense. Environmental Defense is a national nonprofit organization committed to finding economically viable solutions to some of our most serious environmental problems. A large part of my job entails identifying sound incentive mechanisms that will spur environmentally beneficial practices on forest and agricultural lands here in North Carolina and across the Southeast, some of which involve actions to avoid, curb or sequester greenhouse gas emissions.

My comments today will focus specifically on the enormous opportunity carbon offsets could provide the agriculture and forestry sectors in North Carolina. Carbon offset projects essentially are actions that individuals such as farmers and landowners take to avoid greenhouse gas emissions or sequester greenhouse gases. If done properly, these actions can produce high-quality, verifiable greenhouse reductions or credits that can be sold to a variety of entities in what is called a carbon market. While I cannot stress enough that carbon offset projects would be worthwhile merely for their potential to produce immediate greenhouse gas emission reductions, my comments today will focus on the tremendous economic benefits that they offer and the need for the state to help prepare landowners and farmers especially to participate in the emerging carbon offset market.

The state can help facilitate the emergence of agricultural and forestry carbon offset projects by:

(1) Educating farmers and landowners on the emerging carbon offset market – first and foremost so that they undertake activities that produce the highest-quality, most economically competitive offsets. These will be offsets or credits that produce measurable, verifiable and accurate reductions in greenhouse gas emissions. Education will help farmers and landowners know how to seize these opportunities and with whom to partner. Finally, education will help landowners structure projects to protect their interests, financial and otherwise;

(2) Establishing guidance on what makes a truly effective and financially viable carbon offset project. The Duke Standard serves as a very good resource for that guidance; and

(3) Generally promoting high-quality, verifiable carbon offset projects and helping them to get underway as quickly as possible.

Before delving into these specific topics, I would like to provide you with an idea of the projects and work that we at Environmental Defense are already witnessing. I imagine that there are many other projects underway of which we are not yet aware. In addition, I would like to mention that the state's actions to spur carbon offset projects will help to

lay the foundation for some of the recommendations from the CAPAG on agricultural and forestry practices to reduce greenhouse gas emissions. Essentially, carbon offset projects serve as one of the major financial mechanisms by which these activities can be put on the ground.

I. Opportunities – The Interest is Here Already

If I can leave you with one impression today, it is to tell you that our state possesses great potential to generate carbon offsets and that the interest is already strong in investing in these projects in North Carolina. First, let me describe the types of projects that are available to investors in our state. There are a large variety of projects that could qualify.

For example, offsets could be produced by:

- Capturing methane (a potent greenhouse gas) from animal waste and converting it to renewable energy or avoiding methane production in the first place;

- Implementing soil and water conservation best management practices, which include but are not limited to precision application of nitrogen fertilizer, conservation no-till, riparian buffer restoration, and conversion of marginal or highly erodible lands to forests; and

- Sequestering carbon in forest stands and soils through better management practices. This especially is a good option for providing landowners with an added revenue stream so as to withstand development pressure.

Clearly, North Carolina is fertile ground for many of these projects, and the state has caught the attention of many interested parties from within and outside the state. At Environmental Defense, we have seen a steady stream of investors over the past year that have asked our office how to undertake greenhouse gas offset projects in the state. In particular, legislation passed in the 2007 session that established a cost-share program to promote the adoption of innovative hog waste management systems and the renewable energy and energy efficiency portfolio standard have shown investors that there are already resources and a concerted drive to reduce greenhouse gas emissions in the state.

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a. Third Party Verification and Measurement. The state specifically could serve as a verifier and/or help to measure carbon reductions, which could be a substantial transaction cost for individual farmers and landowners. This also could include some type of mechanism to rate aggregators and project developers so that those that want to undertake projects could have a place to turn for unbiased, sound advice on how to structure offset projects and contracts;

b. Carbon offset economic development and recruitment. The state Department of Commerce should develop an economic development strategy to recruit and aggressively court investors and carbon offset entities to invest in North Carolina.

c. Increase private investment by directing Departments of Agriculture, Commerce and DENR to work with key commodity groups, including swine producers, dairy producers, and forest landowners and carbon aggregators to develop major projects;

d. Reduce the costs of environmentally superior hog waste management processes that capture methane and address other pollution problems and attract additional private investment in improving hog waste management by increasing appropriations to the Division of Soil & Water Conservation's NC Lagoon Conversion Cost Share Program; and

IV. Conclusion

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DAQ Suggestions for Course of Action on CAPAG AFW Recommendations

Presentation

to

Legislative Commission on Global Climate Change

December 4, 2007

Raleigh, North Carolina

DAQ Suggestions for Course of Action on CAPAG AFW Recommendations

- (L, Legislative; A, Administrative; R, Regulatory)

- AFW-1 Manure Digesters & Energy Utilization - L
- AFW-2 Biodiesel Production - L
- AFW-3 Soil Carbon Management – L, A, R
- AFW-4a Preservation of Agricultural Land - L
- AFW-4b Preservation of Forest Land - L
- AFW-5 Agricultural Biomass Feed stocks – L, (SB 3)
- AFW-6 Promotion of Ethanol Production – L,R,A

DAQ Suggestions for Course of Action on CAPAG AFW Recommendations, con't.

- AFW-8 Afforestation / Restoration of Non-forested Lands – L,A,R
- AFW- 9 & 10 Expand Use of Forest Biomass and Better Forest Management – L,A,R
- AFW-11 Landfill Methane and Biogas Energy Programs – L,A,R
- AFW-12 Increased Recycling Infrastructure and Collection – L,A,R
- AFW-13 Urban Forestry Measures – A,R, L

Climate Action Plan Advisory Group

Agriculture, Forestry, and Waste Technical Working Group Recommendations

Taken From:

Appendix H of the Draft Mitigation Options for Controlling Greenhouse Gas Emissions

For use at the 4 December 2007 Meeting of the Legislative Commission on Global Climate Change

Appendix H
Agriculture, Forestry, and Waste Management Mitigation Option Recommendations

Summary List of Mitigation Options

	Mitigation Option Name	GHG Reductions ($MMtCO_2e$)			Net Present Value 2007–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of Support*
		2010	2020	Total 2007-2020			
AFW-1	Manure Digesters & Energy Utilization	0.2	0.9	6.4	199	31	UC
AFW-2	Biodiesel Production (incentives for feedstocks and production plants)	0.2	0.8	5.1	286	56	UC
AFW-3	Soil Carbon Management (including organic production methods incentives)	0.2	0.2	3.0	–16	–5	UC
AFW-4a	Preservation of Working Land – Agricultural Land	0.2	0.3	2.6	290	114	UC
AFW-4b	Preservation of Working Land – Forest Land (formerly AFW-7)	1.7	4.3	36	112	3	UC
AFW-5	Agricultural Biomass Feedstocks for Electricity or Steam Production	0.009	0.02	0.2	10	54	UC
AFW-6	Policies to Promote Ethanol Production	0.9	6.9	38	200	5	UC
AFW-7	*Moved to AFW 4a*						
AFW-8	Afforestation and/or Restoration of Non-forested Lands	0.2	2.4	15	128	9	UC
AFW-9&10	Expanded Use of Forest Biomass and Better Forest Management	1.5	5.9	48	–639	–13	UC
AFW-11	Landfill Methane and Biogas Energy Programs	1.1	2.9	20	23	1	UC
AFW-12	Increased Recycling Infrastructure and Collection	0.2	0.5	4.1	4	1	UC
AFW-13	Urban Forestry Measures	1.4	4.3	34	–376	–11	UC
	SECTOR TOTAL AFTER ADJUSTING FOR OVERLAPS	7.8	29	212	222	1	
	REDUCTIONS FROM RECENT ACTIONS (none)	0	0	0	0	0	
	SECTOR TOTAL PLUS RECENT ACTIONS	7.8	29	212	222	1	

* UC = Unanimous Consent (all agree).

AFW-1. Manure Digesters & Energy Utilization
Mitigation Option Description

The methane emissions inherent from the anaerobic decomposition process of manure and other wastes may be captured and used as an energy source. In so doing, it is possible to both reduce methane emissions and to offset fossil-based energy. However, the cost of emission capture and energy production can be higher than the value of the energy collected, making this option cost prohibitive for producers operating in a tight margin business. This option covers programs to increase the number of methane capture and energy recovery projects using manure or other waste (including food processor waste).

Mitigation Option Design

Provide economic incentives / cost offsets for producers interested in manure to energy projects.

- **Goals:** Capture 20% of available methane from confined animal operations by 2020 for use in energy projects. The policy is designed to apply to hog farms and dairies in the state.
- **Timing:** By 2010, implement projects to capture 5% of available methane energy at hog farms and dairies. By 2020, implement projects to capture 20% of methane energy.
- **Parties Involved:** NC Farm Bureau, Department of Environment and Natural Resources. (DENR), NC Department of Agriculture and Consumer Services ((NCDA&CS), livestock producers
- **Other:** Due to the levels of emissions and the cost effectiveness estimated for applying this option to livestock operations in NC, this policy is designed to address hog farms primarily and could also cover dairy producers.

Implementation Mechanisms

- Increased education and outreach to farmers regarding the opportunities for manure digesters. Most farmers cannot implement these recommendations without technical assistance. Traditionally, many farmers rely on USDA's Natural Resource Consrvation Service (NRCS) and North Carolina Cooperative Extension Service (NCCES) for this technical assistance. Additional training is needed for the technical assistance providers in order to better promote the technology.
- Incentives in the form of tax breaks (sales and/or income) for incurred capital costs. Current tax incentives are income tax credits up to 50% of tax burden. During the initial stages of this industry, income is likely to be low and therefore income tax credits will be drastically reduced from the maximum allowed. Restructuring the tax credit to allow for greater recovery of the capital costs will provided a greater incentive to install manure digesters. Exempt manure digester equipment from property and/or sales tax. Existing regulations exempt pollution abatement equipment from property tax, similar exemptions are needed for manure digesters.
- Increased funding for voluntary programs such as NC Green Power and NC Agriculture Cost Share to help offset costs of installing and maintaining manure digesters. These existing programs have a limited ability to fund manure digesters through higher electricity payments

(Green Power) and grants for installation costs (Ag Cost Share). Additional funding for these programs is another incremental step in reaching the recommended goal.

- Increased research to improve return on investment for digesters. Technological improvements have the potential to increase efficiency and lower costs thereby making the manure digesters more economically attractive.
- Allow utilities to pay above avoided cost rates for electricity purchased from manure digesters. Currently, utilities are required to pay small power producers the equivalent of what it would cost the utility to generate the electricity. Allowing the utilities to pay above avoided cost will increase the return on installing a manure digester.
- Education for farmers of power purchase agreements and interconnection with the grid. Farmers should be aware of the interconnection standards required by their local utility including the equipment that will be needed as well as any charges that may apply. Power purchase agreements are essentially the contract between the farmer and the utility that includes rates and length of contract. Making these items as simple as possible and educating the farmers about them will enhance the awareness of the procedures needed to provide electricity to the grid.

Related Policies/Programs in Place

- NRCS cost share program.
- NC Renewable Energy Property tax credit. State income tax credit for 35% of construction costs not to exceed $2.5M or 50% of tax burden.[1]
- EPA AgSTAR Program.
- Federal Renewable Electricity Production Tax Credit.
- USDA Farm Bill Renewable Energy and Energy Efficiency Loan and Grant Program - The Renewable Energy and Energy Efficiency loan and grant program was established under Section 9006 of the 2002 Farm Bill. It provides loan guarantees and grants to agricultural producers and rural small businesses for the purchase and installation of renewable energy systems or for energy efficiency improvements. Loan guarantees cover up to 50% of a project's cost, not to exceed $10 million. Grants are available for up to 25% of a project's cost, not to exceed $250,000 for energy efficiency improvements and $500,000 for renewable energy systems. These loans and grants are expected to reduce greenhouse gas emissions by 0.97 million metric tons, replace 821 million barrels of foreign oil and generate almost 2 million kilowatt hours of electricity annually. USDA has funded more than 800 loans and grants since the renewable energy program began in FY 2003.

Type(s) of Green House Gas (GHG) Reductions

- **CH_4:** methane is captured and typically combusted in an energy recovery system or flared. Small amounts of N_2O and CH_4 are emitted from the combustion process.

[1] North Carolina Incentives for Renewable Energy: http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=NC19F&state=NC&CurrentPageID=1&RE=1&EE=0.

- **CO_2:** carbon dioxide is reduced when the methane is converted to energy and that energy is used to offset fossil-based energy (e.g., coal-fired electricity, natural gas, etc.). Small amounts of N_2O and CH_4 are also reduced from the fossil-based energy that is offset.

Estimated GHG Reductions and Costs (or Cost Savings)

- **GHG reduction potential in 2010, 2020 ($MMtCO_2e$):** 0.2, 0.9.
- **Net Cost per $MtCO_2e$:** $32.
  The cost per ton is the weighted average for dairy ($185) and swine ($31). Since only a very small fraction of the emission reductions are achieved at dairies, the weighted cost effectiveness is nearly identical to that estimated for swine operations. Most of the reductions come from the swine sector. For beef feedlots, the cost effectiveness estimate is much higher ($1,641; due to much lower methane emissions/head), so the Technical Working Group (TWG) does not recommend adopting this policy to address feedlots. These cost estimates include the effects of grants for renewable energy projects from the Federal Farm Bill but do not include the effects of other existing federal and state tax incentives.
- **Data Sources:** NC GHG Inventory & Forecast, North Carolina State University (NCSU) technology determinations for swine farms,[2] other technical reports and presentations on implementing digesters at confined animal operations.[3]
- **Quantification Methods:** *GHG Benefit.* Methane emissions data from the I&F was used as the starting point to estimate the GHG benefits of capturing and controlling the volumes of methane targeted by the policy and to add in the additional benefit of electricity generation using this captured methane (through offsetting fossil-based generation). For 2010 and 2020, the GHG benefit for capturing methane was estimated by multiplying the methane emissions from dairy, feedlot, and swine operations by the applicable goal (5% or 20%) and then by an assumed collection efficiency of 75%,[4] and converting to CO_2e.

  The second portion of the GHG benefit for offsetting fossil-based electricity generation was estimated by converting the methane to captured in each year to its heat content (in BTUs) and then multiplying by an energy recovery factor of 17,100 BTU/kW-hr to estimate the electricity produced (assumes a 25% efficiency for conversion to electricity in an engine and generator set). The CO_2e associated with this amount of electricity in

[2] NCSU Animal and Poultry Waste Management Center, Development of Environmentally Superior Technologies: Phase 3 Report Between the Attorney General of North Carolina and Smithfield Foods, Premium Standard Farms, and Frontline Farms, March 8, 2006, information from this study compiled for the Barham swine farm.

[3] Leonard Bull, Animal and Poultry Waste-to-Energy, PowerPoint presentation, North Carolina State University, See http://www.cals.ncsu.edu/waste_mgt/waste%20to%20energy.pdf, accessed June 2006. See also http://www.methanetomarkets.org/resources/ag/docs/animalwaste_prof_final.pdf, accessed March 2006. Williams, Douglas, Valley Air Solutions, presentation "Joseph Gallo Farms Dairy Manure Digester," January 18, 2006. DPNM Biomass Project Final Report, prepared by Agri-Energy and the Dairy Producers of New Mexico, 2005.

[4] The collection efficiency is an assumed value based on engineering judgment. No applicable studies were identified that provided information on methane collection efficiencies achieved using manure digesters (as it relates to collection of entire farm-level emissions).

each year was estimated by converting the kW-hrs to MW-hrs and then multiplying this value by the NC-specific emission factor for electricity production from the I&F (0.542 Mt/MW-hr).

The total GHG benefit was estimated as the sum of both portions of the benefit described above.

Costs

For swine, costs were estimated using annualized costs for the Barham Farm study, which was part of the North Carolina State University (NCSU) technology determinations referenced in the footnote below. Data from this study indicate a range of annualized costs from $18 to $45/head to cover installation and operation of a digester and an engine-generator set/flare. Annual operations and maintenance costs from this study were $8/head. These costs provide an estimate for the implementation of digester and energy projects at swine farms toward the upper end of the range for U.S. projects with documented costs.[5] Capital costs per head were about $72 for Barham Farm compared to an average of $52/head for seven U.S. swine digester to energy projects.

For dairies and feedlots, data from the EPA methane to markets report and Gallo Farms studies referenced below provided an average cost of $450/head for digesters and engine-generator sets (dairies >1,000 head). From the New Mexico Dairy Producers report, capital costs for regional digesters (those serving multiple nearby operations) were estimated to be $190/head. It is not clear based on available data how well regional digesters could be implemented in NC as they require several dairies in close proximity. Therefore, the average of $450/head was used.

CCS assumed that the 25% Farm Bill grant would be available to each project initiated as a result of this policy.[6] After adjustment of the capital costs, annualized costs per head were estimated assuming a 5% interest rate and a 15-year project life, annual operations and maintenance costs of $38/head were taken from the Gallo Farms Study, and the value of the electricity produced was assumed to be $0.05/kW-hr. Additional incentives to the farmer from the Renewable Energy Production Incentives were not included but could have a small effect on the estimated costs (about $1/Mt$CO_2$e reduced). The annualized per head cost estimates were multiplied by the head of livestock to be controlled in each year to estimate total costs.

- **Key Assumptions:** That the cost data for the studies cited is representative of actual costs; 75% collection efficiency for farm-level methane emissions for the digester. Farm Bill grant will be available to all projects in subsequent cycles of the Farm Bill through 2020. The $0.05/kWh is the assumed value to the farmer for the electricity produced (either to offset on-farm use or to sell back to the grid); this is a conservative estimate.

[5] Moser, M., "A Dozen Successful Swine Waste Digesters", RCM Digesters, Inc., accessed February 2007 at: http://rcmdigesters.com/images/PDF/ADozenSuccessfulSwineWasteDigesters.pdf.

[6] More information on the program is also available at: http://www.rurdev.usda.gov/rbs/farmbill/index.html. The application of this grant incentive was considered a reasonable assumption based on CCS discussions with EPA AgSTAR Program staff; Kurt Roos, personal communication with S. Roe, CCS, March 2007.

Higher values for this electricity would translate into a lower cost effectiveness estimate and a faster return on investment for the farmer.

Key Uncertainties

See key assumptions in the quantification section above.

Additional Benefits and Costs

- *Air & Water Pollution Impacts* - Reductions in emissions of ammonia, volatile organic compounds, and odors (sulfur compounds) are achievable. Reductions occur when anaerobic digesters and energy utilization are used to capture emissions that would have occurred from the lagoon surface. Note that these reductions occur at the lagoon surface and that there is a potential for increased ammonia emissions during application of digester effluent to fields due to high ammonium concentrations, if measures are not taken to avoid these emissions. Ammonia emissions are important in the formation of fine particulate matter and nitrogen deposition to sensitive water sheds. Also, there will be an increase in emissions of nitrogen and sulfur oxides during the combustion of biogas. Both of these pollutants are also fine particulate matter precursors, and oxides of nitrogen are a precursor of ozone.

  Measures to reduce both air and water pollution impacts could include the use of nitrifying/denitrifying systems to reduce the ammonium concentration prior to application. In these systems, ammonium is converted to nitrogen which is released instead of ammonia. (Care must be taken to avoid excessive nitrous oxide emissions, however.) The other option is to identify and produce marketable products from the digester effluent, which would have to be trucked off the farm. The increased GHG emissions associated with transporting any such products have not been factored in to the analysis conducted for this option.

  A study of an anaerobic digester project for a dairy farm[7] demonstrated that these projects can substantially reduce total volatile solids (39.5%) and chemical oxygen demand (38.5%). These reductions translate directly into a lower potential for depletion of dissolved oxygen in natural waters. Although anaerobically digested manure is not suitable for direct discharge to surface or ground waters, these reductions still are significant due to the potential for these wastes to enter surface waters by nonpoint source transport mechanisms. The study also showed that mesophilic anaerobic digestion at an average hydraulic retention time of 29 days reduced the mean densities of the fecal coliform group of enteric bacteria by 99% and fecal streptococcus group by 90%;

- Possible nutrient management benefits for situations where ammonium-rich effluent can be used without excessive ammonia emissions;
- Economic benefits for the digester industry.

Feasibility Issues

- Currently a long return on investment.

[7] "An Evaluation of a Mesophilic, Modified Plug Flow Anaerobic Digester for Dairy Cattle Manure", prepared by Eastern Research Group, prepared for the U.S. EPA AgSTAR Program, July 20, 2005.

- Demand from electric utilities and other entities seeking renewable energy sources.
- Utility barriers including grid interconnection and electricity standby costs charged to the farmer.

Status of Group Approval

Complete

Level of Group Support

Unanimous

Barriers to Consensus

None

AFW-2. Biodiesel Production (Incentives for Feedstocks and Production Plants)

Mitigation Option Description

Use of biodiesel offsets the consumption of diesel fuel produced from oil (fossil diesel). Since biodiesel has a lower GHG content than fossil diesel, overall GHG emissions are reduced. By producing biodiesel in the state for consumption within the state, the highest benefits can be achieved, since the fuel is transported over shorter distances to the end user. This option covers incentives needed to increase biodiesel production in North Carolina.

Note: This option is linked with Transportation & Land Use (TLU) Option 7 on Biofuels. This option seeks to achieve incremental GHG benefits beyond the TLU option by promoting in-state production of biodiesel using feedstocks with greater GHG benefits than the likely business as usual national production methods. In addition, NC consumption of biodiesel produced in-state will produce better GHG benefits than biodiesel obtained from a national market due to lower embedded CO_2 associated with transportation of biodiesel or its feedstocks from distant sources.

Mitigation Option Design

- **Goals:** Produce enough biodiesel to offset 12.5% of NC's fossil diesel consumption by 2020.
- **Timing:** By 2010, produce enough biodiesel to offset 5% of fossil diesel consumption. By 2020, produce enough biodiesel to offset 12.5% of in-state fossil diesel consumption.
- **Parties Involved:**. NCDA&CS, Department of Administration, Motor Carrier Enforcement Division, DENR, Department of Commerce, NC Rural Center, NCSU, North Carolina Agricultural & Technical State University (NCA&T), other state agencies, agricultural associations which represent producers of feedstock, petroleum industry trade groups, and various industry associations.
- **Other:** NA

Implementation Mechanisms

- Incentives in the form of grants or tax breaks (sales and/or income) for incurred capital costs for feedstock producers (oil crops, methanol/ethanol).
- Streamlined permitting of production facilities. Technical assistance for new producers.
- Incentives and grants for expanded research for oilseed production and processing (including canola and other crops not typically grown in NC).
- Active solicitation of new producers.
- Expanded consumer education to drive demand.
- Expanded producer education to develop skilled workforce.

Related Policies/Programs in Place

- NC Renewable Energy Property tax credit. State income tax credit for 35% of construction costs not to exceed $2.5M or 50% of tax burden.
- Federal Biodiesel Mixture Tax Credit. Federal excise tax credit for biodiesel mixtures, ranges from $0.50 to $1.00/gallon depending on feedstock.

Type(s) of GHG Reductions

- **CO_2:** Lifecycle emissions are reduced to the extent that biodiesel is produced with lower embedded fossil-based carbon than conventional (fossil) diesel fuel. Feedstocks used for producing biodiesel can be made from crops, which contain carbon sequestered during photosynthesis (e.g., biogenic or short-term carbon). The primary feedstocks are vegetable oils (soy, canola, sunflower, algal, etc.) and alcohols (either methanol or ethanol). From a recent report (Hill et al., 2006),[8] biodiesel from soybeans contains 93% more useable energy than its petroleum equivalent and reduces lifecycle GHG emissions by as much as 41%. Higher oil production potential of different feedstocks (e.g., other oil crops, algae) will likely adjust the lifecycle GHG emissions further downward as they are developed as biodiesel sources. Local production of biodiesel also decreases the embedded CO_2e of biodiesel compared to importation of out of state vegetable oil supplies.

Estimated GHG Reductions and Costs (or Cost Savings)

- **GHG reduction potential in 2010, 2020 ($MMtCO_2e$):** 0.2, 0.8.
- **Net Cost per $MtCO_2e$:** $56.
- **Data Sources:** Data from the NC Inventory & Forecast were the starting point for quantifying the benefits of offsetting fossil diesel consumption with biodiesel produced within the state (these do not incorporate future reductions in consumption due to TLU options). Fossil diesel consumption estimates are shown in Table H-1 (under business as usual).

Table H-1.

Year	Diesel Consumption (MMgal/yr)
2010	1,470
2020	2,157

The policy design calls for 5% of the fossil diesel consumption to be offset by 2010 from in-state production and 12.5% offset by 2020. Biodiesel production targets are shown in Table H-2.

[8] Hill et al, 2006, "Environmental, economic, and energetic costs and benefits of biodiesel and ethanol biofuels," *Proceedings of the National Academy of Sciences*, volume 103, pp. 11206-11210, July 25, 2006.

Table H-2.

Year	Biodiesel Production Needed (MMgal/yr)
2010	71
2020	259

By 2010, "business as usual" (BAU) biodiesel production in the state is expected to be 3 MMgal.[9] By projecting the 2007 to 2010 BAU production growth rate (0 to 3 MMgal/yr), the estimated 2020 BAU production level would be 10 MMgal/yr. Hence, by 2020, this option would try to increase the production levels to about 249 MMgal/yr (see Table H-3.

Table H-3.

Year	Biodiesel Production Needed Beyond BAU (MMgal/yr)
2010	68
2020	249

The CO_2e emission factor for fossil diesel used in the inventory and forecast is 10.04 Mt/1,000 gallons. The lifecycle fossil diesel emission factor is 12.3 Mt/1,000 gallons (Hill et al., 2006; cited in the footnotes).

- **Quantification Methods:**

  GHG Reductions

  A new study on lifecycle GHG benefits for biodiesel production and use was used to estimate the CO_2e reductions for this option (Hill et al, 2006; cited in footnotes to this option). This study covered biodiesel production from soybean production, which is currently the predominant feedstock source for biodiesel production in the US and is assumed to remain that way for the purposes of this analysis. (It is also the predominant source of vegetable oil production in NC.) Lifecycle CO_2e reductions (via displacement of fossil diesel with soybean-derived biodiesel) were estimated by Hill et al to be 41%. This value is being used by the TLU TWG to estimate the benefit of the biodiesel component of the TLU biofuels option. Hence, this analysis focuses on incremental benefits of in-state feedstocks production with the focus on vegetable oils.

  For this option, the incremental benefit of in-state production is derived from the lower embedded GHG content of biodiesel feedstocks (vegetable oil) avoided from having to transport the feedstocks from their likely source region. For this assessment, the likely source regions for soybean or canola oil are the U.S. mid-west or northern plains regions. Using South Dakota as a potential source region, rail transport would require shipments

[9] www.eere.energy.gov/states/state_news_detail.cfm/news_id=10298/state=NC; USDOE Energy Efficiency and Renewable Energy website, accessed 1/16/07; Piedmont Biofuels begins operation in late 2006 (1 MMgal/yr capacity); one of three plants being built in NC; assume similar capacity for the remaining two and that these will be operational by 2010.

to central North Carolina of about 1,400 miles.[10] Rail fuel consumption is about 400 ton-miles/gallon.[11] The density of vegetable oil is about 3,700 tons/MMgal. From these inputs, a GHG emission rate of 130 $MtCO_2$/MMgal oil was calculated.

When combined with the other feedstocks needed to produce biodiesel (e.g., either methanol or ethanol),[12] a gallon of vegetable oil will produce slightly more than one gallon of biodiesel. For the purposes of this estimate, each gallon is assumed to produce one gallon of biodiesel.

In addition to soybean oil, other oil feedstocks included in this analysis include animal oils (yellow grease, poultry fat, lard, and tallow), canola, and algal oils. As mentioned under the feasibility section below, current production of these feedstocks in NC would not meet the goals of the proposed policy (no canola or algal oils are currently produced). Even after substituting canola production for all of the current wheat production in NC, the 2020 production goal would not be met. Hence, it is assumed that technology advances will occur during the policy period that will allow for commercial scale production of algal oil to make up the shortfall (e.g., in the post-2015 period). With sufficient technology advancement, another option could be Fischer-Tropsch biodiesel from cellulose.

For oil sources other than soybean oil, the benefit for substituting in-state biodiesel for fossil diesel is estimated starting with the lifecycle soybean emission factor (7,261 $MtCO_2e$/MMgal from the Hill et al study). As mentioned previously, the benefits of the biodiesel component of the TLU biofuels option is based on displacement with soybean-based biodiesel. Hence, this analysis was designed only to account for the incremental benefit of in-state feedstock (oil) production using GHG preferential feedstocks. These include vegetable oils that produce greater volumes of oil per unit of energy input (e.g., canola), animal fats, and, in the future, algal oils.

Canola produces 127 gallons of oil per acre compared to soybeans at 48 gallons/acre. Assuming canola production energy inputs are not significantly greater than soy, the lifecycle emission rate for canola would be 7,261 x 48/127 or 2,744 $MtCO_2e$/MMgal. So the incremental benefit of canola over soy is 7,261 - 2,744 = 4,517 $MtCO_2e$/MMgal.

For animal fats and algal oils, CCS assumes that these have negligible embedded energy. So the incremental benefit over soy equals the lifecycle fossil diesel emission factor (EF) (12,306 $MtCO_2e$/MMgal) minus the soybean based EF (7,261 $MtCO_2e$/MMgal), which is 5,045 $MtCO_2e$/MMgal.

To meet the in-state production goals for 2010 and 2020, Table H-4 provides the mix of oil feedstocks assumed in this analysis. The assumed mix relies heavily on new technologies (e.g., algal oil) to produce feedstocks in the post-2010 period. The new production data summarized below exclude BAU production, which is estimated to be 3

[10] U.S. National Atlas, at http://nationalatlas.gov/natlas/Natlasstart.asp.

[11] U.S. National Atlas, at http://nationalatlas.gov/articles/transportation/a_freightrr.html.

[12] While the analysis here focuses on the primary feedstock for biodiesel, vegetable oil, the policy should also promote the production and use of alcohol feedstocks produced from renewable resources (e.g., starch or cellulosic ethanol, renewable methane to methanol).

MMgal/yr in 2010 and 10.3 MMgal/yr in 2020[13] (BAU production is further assumed to be soybean-based with little incremental benefit above the TLU Option 6 benefit).

Table H-4.

Year	Oil Feedstock	Fraction of New Production	MMgal/yr Needed*
2010	Soy	0.40	27
2010	Canola	0.10	7
2010	Animal	0.50	34
2010	Algal	0.00	–
		2010 Total	**68**
2020	Soy	0.12	30
2020	Canola	0.25	62
2020	Animal	0.20	50
2020	Algal	0.43	107
		2020 Total	**249**

* Excludes BAU production estimated to be 3 MMgal/yr in 2010 and 10.3 MMgal/yr in 2020.

GHG reductions were estimated by multiplying the production of each oil feedstock by the applicable incremental benefit (e.g., by oil type). Total reductions in each year were estimated by summing the incremental benefit for each oil type.

Costs

Costs were estimated using information from an analysis of biodiesel production costs from the US DOE.[14] The value of incentives needed is assumed to be equivalent to the difference in the costs of producing fossil diesel and soy-based biodiesel ($0.34/gallon). This value is very close to the incentive offered in a State of Missouri incentives program.[15] This program offers production incentives of $0.30/gallon to producers up to 15 million gallons of production/yr. The incentive grants last for five years.

CCS assumed a similar incentive structure and that these would cover the costs of all grants or tax incentives associated with this policy (all other implementation mechanisms are assumed to be achieved within existing programs). The cost estimates are based on multiplying the amount of biodiesel produced in each year by the production incentive. This assumes that all production occurs at production facilities of less than 15 million gallons/yr. The production incentive runs out after five years of production.

[13] See www.eere.energy.gov/states/state_news_detail.cfm/news_id=10298/state=NC, USDOE Energy Efficiency and Renewable Energy; Piedmont Biofuels begins operation in late 2006. One of three plants being built. Assume similar capacity for the remaining two to be operational by 2010. After 2010, assumes BAU growth is at the estimated 2007-2010 growth rate (0.7 MMgal/yr).

[14] See www.eia.doe.gov/oiaf/analysispaper/biodiesel/index.html; accessed January 2007.

[15] Information on the Missouri Program: www.newrules.org/agri/mobiofuels.html#biodiesel, accessed January 2007.

- **Key Assumptions:** Life-cycle GHG emission factors utilized/derived for this analysis are representative for each feedstock and for fossil diesel. Production incentives offered by this option are sufficient to drive production of GHG-superior feedstocks (e.g., superior to soybeans) and to increase the level of research and development needed for non-crop based feedstocks (e.g., algal biodiesel, Fischer-Tropsch biodiesel).

Key Uncertainties

Pending

Additional Benefits and Costs

- Additional markets for oilseed crops and animal fats.
- Economic growth from locally produced fuels.

Feasibility Issues

Current production of biodiesel feedstocks in NC are provided in Table H-5.[16]

Table H-5.

	Million gallons per year
Soy oil	60.5[17]
Canola oil	0
Yellow grease	10
Poultry fat	21
Lard	21
Tallow	2
Total Current Feedstocks	**114.5**

By converting all NC wheat to canola production, another 66 MMgal/yr could be produced,[18] yielding a total of about 180 MMgal/yr. Given that the policy requires about 250 MMgal/yr by 2020, these data show the importance of additional research and development and production incentives for other non-crop sources of biodiesel feedstock oil. These include production of oil from algae and Fischer-Tropsch biodiesel from cellulose.

Status of Group Approval

Complete

Level of Group Support

Unanimous

Barriers to Consensus

None

[16] Henry Tsai, economist, NCSU Solar Center, 2004 slideshow, "Implications of Rising Energy Cost on the Economy: 3 Different Perspectives."

[17] NC Biomass Resource Inventory 2003. This oil production figure was calculated based on 43,200,000 bushels of soy grown in North Carolina.

[18] Kurt Creamer, North Carolina State University, personal communication with S. Roe, CCS, January 16, 2007.

AFW-3. Soil Carbon Management

Mitigation Option Description

Use of conservation tillage, no-till methods, cover cropping, and other soil management practices can increase the level of organic carbon in the soil, which sequesters carbon dioxide. In addition, some practices lower fossil fuel consumption through less intensive equipment use. Other practices, such as the application of bio-char can also increase the level of soil carbon and improve the soil.

Another element of this option is the promotion of certified organic production techniques. A number of studies have found that organic production of row crops result in GHG benefits, including higher levels of soil organic carbon, relative to conventional production methods. This option is designed to increase the acreage using soil management and production practices that lead to higher soil carbon content and other GHG benefits.

Mitigation Option Design

- **Goals:** By 2020, apply soil management practices on 50% of cultivated lands that currently do not use these techniques. Also, identify and promote organic production techniques that have been demonstrated in NC to achieve net GHG benefits.
- **Timing:** By 2010, apply soil management practices on 20% of acres that currently do not use these practices. Achieve an increase to 50% of these acres by 2020. By 2010, complete a systematic assessment of organic cultivation systems for NC crops and identify those that achieve net GHG benefits. Initiate programs to promote these organic cultivation methods through 2020.
- **Parties Involved:** NC Department of Agriculture (CEFS), NC Department of Environement and Natural Resources (DENR), NCSU (CALS, CNR), NC Extension, other agricultural organizations and associations.
- **Other:** Studies in NC have found the potential to sequester one ton of carbon per acre through conservation tillage/no-till practices over a six-year period[19] (equivalent to about 3.3 $MtCO_2e$/acre). Studies in California[20] and Pennsylvania[21] have shown that certified organic production methods of row crops sequester dramatically more carbon than

[19] Available at http://southeastfarmpress.com/news/030106-Naderman-conservation/.

[20] Source: *Conservation tillage and cover cropping influence soil properties in San Joaquin Valley cotton-tomato crop,* by Jessica J. Veenstra, William R. Horwath, Jeffrey P. Mitchell and Daniel S. Munk. California Agriculture Journal, July-Sept. 2006.

[21] Chapter in book: "The Rodale Institute Farming Systems Trial 1981 to 2005: Long Term Analysis of Organic and Conventional Maize and Soy-bean Cropping Systems," pp15-30, in *Long Term Field Experiments in Organic Farming*, edited by J Rauppe, C Perkrun, M Oltmanns, U Kopke. ISOFAR - International Society of Organic Agricultural Research, Verlaug Publishing, Berlin, 2006.

conventional practices. Both studies independently concluded that fully-tilled organic production can sequester 1000 lbs per acre per year.[22] Soil carbon accumulations up to 28,000 lbs per acre were observed in the 25-year field trial performed at the Rodale Institute.

A recent study in the United Kingdom[23] found that some organic production techniques have higher energy inputs or land requirements than conventional techniques (sometimes due to lower yields, longer production cycles for livestock like poultry). Because increases in soil carbon content do not fully reflect crop production cycle GHG emissions (due to changes in tillage practices, application of chemicals, etc.), research and pilot studies will be needed to determine which organic cropping systems in NC achieve net GHG benefits (see Feasibility Issues section below).

Implementation Mechanisms

- Increase NC Agriculture Cost Share funding to include additional acreage in no-till and organic farming techniques.
- Create a Cost Share program to help producers through the process of organic certification.
- Expand educational programs through NCCES on conservation tillage and certified organic production techniques.
- Research the organic production systems suitable for North Carolina that produce net GHG benefits. Actively promote penetration of organic production methods within these systems.
- Research the availability and effectiveness of bio-char application.
- Research the need for infrastructure to facilitate in-state farmers moving their organically produced goods to market.
- Incentives in the form of grants, tax breaks, or loan guarantees for development of infrastructure needed for certified organic commodities and crops.

Related Policies/Programs in Place

- NC Agriculture Cost Share Program for no-till; $125/acre with a 120-acre cap for switching to no-till for 5 consecutive years.
- NRCS cost share programs.

Type(s) of GHG Reductions

- **CO_2:** Reducing tillage and soil disturbance slows the breakdown of plant material on the soil surface and in the root zone, accelerating the microbial processes that stabilize carbon and protecting carbon from oxidation, inhibiting the release of carbon back into

[22] Source: Interview with Dr Paul Hepperly, Rodale Institute, February 8, 2007.

[23] *Environmental Impacts of Food Production and Consumption,* Manchester Business School, prepared for the Department for Environment, Food and Rural Affairs, December 2006, http://www.defra.gov.uk/science/project_data/DocumentLibrary/EV02007/EV02007_4601_FRP.pdf.

the atmosphere. Depending on how the adoption of conservation tillage and organic production methods affects the overall crop production cycle, additional CO_2 reductions can occur through lower fossil fuel consumption in farm equipment. Note that some studies have shown higher fuel consumption using organic techniques than conventional production. Also, organic production methods reduce GHG emissions associated with the production, transport, and application of pesticides, herbicides, and other chemical treatments.

- **N_2O:** To the extent that fossil fuel consumption is lowered through the cultivation methods implemented under this policy, N_2O emissions from fuel combustion will be lowered. *It is important to note that research also indicates the potential for higher N_2O emissions as soil organic carbon levels increase* (see Feasibility Issues Section below).
- **CH_4:** To the extent that fossil fuel consumption is lowered through the cultivation methods implemented under this policy, CH_4 emissions from fuel combustion will be lowered.

Estimated GHG Reductions and Costs (or Cost Savings)

- **GHG reduction potential in 2010, 2020 ($MMtCO_2e$):** 0.2, 0.1.
  Note: The GHG reductions above and costs below do not reflect the organic production incentives elements of this option. Because agricultural soils will only accumulate carbon up to a certain level before tapering off, the GHG benefit decreases in the post-2020 period to about 0.05 $MMtCO_2e$/yr after 2025. The remaining benefit, which is permanent, is associated with lower fossil fuel consumption.
- **Net Cost per $MtCO_2e$:** -$5.
- **Data Sources:** Agricultural soil carbon accumulation levels were taken from a 2006 study by Naderman et al.[24] This study found a range of soil carbon accumulation in different NC cropping systems of 1,000-3,000 lb/acre. These accumulations occurred following a period of six consecutive years of no-till farming. Data on current (2004) acres of cropland where conservation till/reduced till practices are employed were taken from the Conservation Technology Information Center (CTIC).[25] These data show that NC had 4,234,965 planted acres in 2004. In 2004, 2,292,104 acres were cultivated using conservation tillage or reduced tillage methods.

  The reduction in fossil diesel fuel use from the adoption of conservation tillage methods is 3.5 gallons/acre.[26] From the NC Inventory & Forecast, the fossil diesel GHG emission factor is 8.37 $MtCO_2e$/1,000 gallons.

  Adoption of conservation tillage/no-till practices are estimated to result in a cost savings for the grower. Work by NCSU on applying these practices to cotton growing in NC

[24] Naderman, G., B.G. Brock, G.B. Reddy, C.W. Raczkowski, *Long Term No-Tillage: Effects on Soil Carbon and Soil Density Within the Prime Crop Root Zone*, Project Report, NCSU, January 2006.

[25] 2004 CTIC data provided by Paul Sherman of the NC Farm Bureau, February 2006.

[26] Reduction associated with conservation tillage compared to conventional tillage, at http://www.ctic.purdue.edu/Core4/CT/CRM/Benefits.html, accessed August 2006.

resulted in a range of cost savings from about $3 to $14 per acre per year.[27] CCS used the low end of the range as a conservative estimate of cost savings for this policy option. An older cost study for no-till versus conventional tillage methods for corn and soybeans in NC showed significant cost savings for no-till methods for most cropping systems and tillage methods ($5-$20/acre).[28] Given that these were based on 1981 data (including fuel prices), the cost savings in today's dollars would be much larger. No additional cost benefits were incorporated for the cost share programs noted above.

- **Quantification Methods:** Based on the policy design parameters, the schedule for acres to be put into conservation tillage/no-till cultivation are shown in Table H-6. The mid-point of the estimated range for carbon sequestration (2,000 lb/acre) in NC agricultural soils was used to estimate the total amount of carbon to be sequestered. Based on the Naderman et al study referenced above, it was further assumed that this additional carbon would be sequestered in the soil over a period of six years (after six years no further carbon is stored). The resulting annual carbon accumulation rate was converted into its CO_2 equivalent yielding 0.55 $MtCO_2$/acre-yr.

  To estimate carbon stored each year, the annual accumulation rate was multiplied by the number of acres in the policy program each year. After six years, the crop acres that entered the program were assumed to not store additional carbon. Results are shown in Table H-6.

  Additional GHG savings from reduced fossil fuel consumption were estimated by multiplying the fossil diesel emission factor and diesel fuel reduction per acre estimate provided above. Results are shown in Table H-6 along with a total estimated benefit from both carbon sequestration and fossil fuel reductions.

  Costs were estimated by multiplying the estimated savings per acre cited above ($3) by the number of acres in the program each year. The effects of other existing incentive programs were not taken into account in these estimates.

- **Key Assumptions:**

  These include: the of the assumed carbon sequestration potential is representative across all of the crop systems to which the policy is applied; a six-year period for accumulating the soil carbon; no additional significant accumulation of soil carbon after six years; any potential increase in N_2O emissions (see Feasibility Section below) is not large enough to significantly effect the estimated benefits; the cost savings is a representative average of savings to be achieved across all crop systems.

[27] $3-$14/acre savings dependent on comparison of no-till to either strip till or conventional tillage. From: Economic Comparison of Three Cotton Tillage Systems in Three NC Regions, S. Walton and G. Bullen, NCSU, atwww.ces.ncsu.edu/depts/agecon/Cotton_Econ/production/Economic_Comparison.ppt, accessed February 2007.

[28] *No-Till Crop Production Systems in North Carolina – Corn, Soybeans, Sorghum, and Forages*, North Carolina Agricultural Extension Service, date unknown, accessed February 2007, at www.ag.auburn.edu/aux/nsdl/sctcsa/Proceedings/1981/1981_SCTCSA.pdf.

Table H-6. Assumed Schedule for Adoption of Conservation Tillage/No-Till Practices and Associated Benefits

Year	Acres in Program	Acres still accumulating carbon	$MMtCO_2e$ Sequestered	Diesel Saved (1,000 gal)	Diesel GHG avoided ($MMtCO_2e$)	Total $MMtCO_2e$ saved
2007	97,393	97,393	0.054	341	0.0029	0.0568
2008	194,786	194,786	0.108	682	0.0057	0.1137
2009	306,788	306,788	0.170	1,074	0.0090	0.1791
2010	389,572	389,572	0.216	1,364	0.0114	0.2274
2011	448,008	448,008	0.248	1,568	0.0131	0.2615
2012	506,444	506,444	0.281	1,773	0.0148	0.2956
2013	564,880	467,487	0.259	1,977	0.0166	0.2757
2014	623,316	428,530	0.238	2,182	0.0183	0.2558
2015	681,752	374,964	0.208	2,386	0.0200	0.2279
2016	740,188	350,615	0.194	2,591	0.0217	0.2161
2017	798,624	350,615	0.194	2,795	0.0234	0.2178
2018	857,059	350,615	0.194	3,000	0.0251	0.2195
2019	915,495	350,615	0.194	3,204	0.0268	0.2212
2020	973,931	350,615	0.194	3,409	0.0285	0.2229
2021	973,931	292,180	0.162	3,409	0.0285	0.1905
2022	973,931	233,744	0.130	3,409	0.0285	0.1581
2023	973,931	175,308	0.097	3,409	0.0285	0.1257
2024	973,931	116,872	0.065	3,409	0.0285	0.0933
2025	973,931	58,436	0.032	3,409	0.0285	0.0609
2026	973,931	0	0.000	3,409	0.0285	0.0285
2027	973,931	0	0.000	3,409	0.0285	0.0285
2028	973,931	0	0.000	3,409	0.0285	0.0285
2029	973,931	0	0.000	3,409	0.0285	0.0285
2030	973,931	0	0.000	3,409	0.0285	0.0285

Key Uncertainties

See "key assumptions" in the previous section. Note that the benefits and costs of the application of bio-char to agricultural soils have not been included in this analysis. Within the period of analysis for this policy, bio-char application could become another element of this program to increase soil carbon levels in agricultural soils.

Additional Benefits and Costs

Organic production under offers considerable economic market benefits: Certified producers are receiving premium prices for their harvests.

The dramatic increases in soil carbon with certified organic production methods offer further benefit in periods of drought or extreme rain. The Rodale Farming Systems Trial has quantified

superior crop production during droughts, compared to conventional no-till production, because soils in the organic plots captured more water and retained more of it in the crop root zone than in the conventional no-till plots. During torrential rains, water capture in the organic plots was approximately 100% higher than in conventional no-till plots.[29]

Feasibility Issues

The goal of expanding organic production by 10% is modest and feasible, and has been easily beaten by our foreign competitors: During the period of 2002 to 2006, China's certified organic acreage grew 8,650% (from 40,000 to 3.5 million); Uruguay, 58,285% (1,300 to 759,000); Chile, 1,200% (3,000 to 39,000); and Mexico 243% (86,000 to 295,000). The growth in Uruguay, Chile, and Mexico was entirely driven by market demand, not subsidies or policies.[30]

Our acreage goal has been easily achieved and surpassed by other states in the USA: From 2000 to 2005 California's total certified organic acreage of cropland grew from 141,000 to 223,000, a more than doubling.[31]

Research has indicated a potential for increased N_2O emissions as soil organic carbon levels increase.[32] Additional study and field work on NC cropping/soil systems will be needed to verify the GHG reduction potential estimated in this policy analysis for no till cultivation.

More importantly, additional study of organic production systems applicable to NC is needed to determine full crop production cycle GHG benefits. Known benefits for organic production systems include:

- *CO_2 Capture*: cover crops used in organic production actively capture atmospheric CO_2, and full-tilling incorporates it into the soil deeper and faster than conventional no-till. Organic production methods cause crops to grow more root mass, deeper than with conventional methods, creating deeper accumulation of soil carbon, allowing for greater long-term accumulation.[33]
- *Avoided CO_2 Release*: by using animal manure, compost, and cover crops as fertilizers, certified organic production methods do not oxidize the soil carbon as nitrogen fertilizer does. The lime applied to adjust the pH actually releases CO_2.[34]

[29] Source: *"The performance of organic and conventional cropping systems in an extreme climate year,"* D.W. Lotter, R. Seidel, and W. Liebhardt, Rodale Institute, American Journal of Alternative Agriculture, September 2003, vol. 18, no. 3, pp. 146-154(9).

[30] Source: *"The World of Organic Agriculture: Statistics & Emerging Trends 2006,"* by Helga Willer and Minou Yussefi, IFOAM (International Federation of Organic Agriculture Movements), 2006, Bonn, Germany. http://orgprints.org/5161/01/yussefi-2006-overview.pdf

[31] Source: Interview with Catherine Greene, USDA Economic Research Service, February 8, 2007.

[32] Li et al., "Carbon Sequestration in Arable Soils is Likely to Increase Nitrous Oxide Emissions, Offsetting Reductions in Climate Radiative Forcing" *Climate Change*, (2005) 72: 321–338.

[33] Source: Interview with Dr. Paul Hepperly, Rodale Institute, February 8, 2007.

[34] Source: Interview with Dr. Paul Hepperly, Rodale Institute, February 8, 2007.

- *Avoided GHG Emissions in Production of Inputs*: nitrogen fertilizer, pesticides, and herbicides used in conventional agriculture (including conventional no-till), require process energy and petro-chemicals in their production. Organic production methods grow their fertilizers (or use manures and composts), and control weeds and pests in ways that have a lower life-cycle energy cost.[35]
- *Greater Overall Soil Carbon and GHG Benefits*: No-till conventional uses more energy and produces more CO_2 than full-tillage organic row crop production with cover crops. The energy burned in diesel fuel is less than the embodied energy in the avoided fertilizer and lime.[36]

Recent study in the United Kingdom found that in many but not all organic production systems that net GHG emissions were reduced.[37] Organic farming's weaknesses were identified as: 1) similar inputs into the farm including manufacture/operation of machinery and packaging; 2) in some cases, significantly lower yields resulting in higher GHG emissions per ton of product; and 3) slower maturing of animals (more GHG per ton product).

It will be important for NC to study and identify the organic production systems best suited to the state and that produce net GHG benefits. In conjunction with implementation of this policy NCSU's Agronomy Division, Soil Testing Service, can provide the service of soil carbon measurements on the soil samples certified producers are already required to submit.

Status of Group Approval

Complete

Level of Group Support

Unanimous

Barriers to Consensus

None

[35] Environmental, Energetic and Economic Comparisons of Organic and Conventional. Farming Systems, David Pimentel, Paul Hepperly, James Hanson, David Douds, Rita Seidel. *BioScience*, July 2005 / Vol. 55 No. 7.

[36] Source: Interview with Dr. Paul Hepperly, Rodale Institute, February 8, 2007.

[37] Melchett, P., "One planet agriculture – the strengths and weaknesses of organic food and farming", Soil Association Conference 2007, January 26, 2007, http://www.soilassociation.org.uk/Web/SA/saweb.nsf/cfff6730b881e40e80256a6a002a765c/902f12def991d13a80256f9c005e300e/$FILE/conference_melchett.pps.

AFW-4a. Preservation of Working Lands – Agricultural Land

Mitigation Option Description

Reduce the rate at which existing crop and pasture are converted to developed uses. The carbon sequestered in soils and aboveground biomass is much higher in croplands than in developed land uses. Policies are needed to preserve working farms and forests (see AFW-4b) from unwise and unplanned development. This option should be seen as a companion measure to TLU-1a (Land Development Planning).

Mitigation Option Design

State and national programs have been established to protect farm communities from conversion to development. Funding state farmland preservation programs will help meet goals and act as a needed match to national programs. Programs are being investigated that help farmers transition lands to beginning farmers.

- **Goals:** Reduce the rate at which agricultural lands are converted to developed use by 50% by 2020 from current levels.
- **Timing:** By 2010, reduce the rate of conversion by 20% from current levels. By 2020, reduce the rate of conversion by 50%.
- **Parties Involved:** NCDA&CS, NC Farm Bureau, NCDF, USDA-Forest Service, NC Dept. of Forest Resources (NCDR), NCSU, and NC Farm Transition Network.
- **Other:** North Carolina lost 5,500 farms and 300,000 acres between 2003-2006.[38]

Implementation Mechanisms

- Increased funding for state farmland preservation programs.
- Increased public education on the benefits of preserving agricultural land.
- Inclusion in voluntary programs such as NC Agriculture Cost Share.
- Increased funding from General Funds.
- Increase funding for Agricultural Development and Farmland Preservation Trust Fund (protects forest and farmlands).
- Farm Bill Conservation Title- EQIP, CRP, CREP.
- Encourage counties to construct County Farmland Protection Plans in order to identify and plan to protect their farm and forestland production areas.
- Engage local governments and nongovernmental organizations on recruiting farmers to take part in protection programs and in developing funding mechanisms to support the plans.

[38] Max Merrill, NCDA&CS, personal communication with S. Roe, CCS, March 15, 2007.

Related Policies/Programs in Place

- Agricultural Development and Farmland Preservation Trust Fund.
- Present Use Tax Valuation.
- North Carolina Conservation Tax Credit.
- Farm and Ranchlands Protection Program.
- Forest Legacy Program.
- EQIP, WRP, CRP, CREP, and WHIP.
- Million Acre Initiative.

Type(s) of GHG Reductions

- **CO_2:** Conservation of agricultural lands retains the ability of the land to sequester carbon in soil and biomass. Also, emissions are indirectly reduced to the extent that development patterns are influenced and vehicle miles traveled (VMT) are reduced (see TLU Option 1a).
- **CH_4 and N_2O:** Are also indirectly reduced as VMT are reduced.

Estimated GHG Reductions and Costs (or Cost Savings)

- **GHG reduction potential in 2010, 2020 ($MMtCO_2e$):** 0.2, 0.3.
- **Net Cost per $MtCO_2e$:** $114.

  Note: The reductions and cost per Mt estimated for this option only refer to the direct benefits and costs associated with the estimated loss of soil carbon from agricultural soils due to development. They do not include the indirect benefits of more efficient development patterns that could result from this option (see TLU Option 1a).

- **Data Sources:**

  The annual rate of agricultural land conversion in NC is 100,000 acres per year based on the footnoted reference above. This is very close to another estimate of 101,600 acres/yr taken from a 2001 study.[39] The typical level of soil carbon in agricultural soils in NC was taken from a 2002 study of Piedmont soils (0.017 MMtC/1,000 acres for the top eight inches of soil).[40] The cost of establishing conservation easements on agricultural lands surrounding developing areas was taken from NRCS information on the Farm

[39] 1992-1997 rate of conversion from - Commission on Smart Growth, *Growth Management and Development: Findings and Recommendations*, Fall 2001, at www.eatsmartmovemorenc.com/resources/documents/aces/aces_smartgrowth.pdf.

[40] Franzluebbers, A.J., B. Grose, L.L. Hendrix, P.K. Wilkerson, B.G. Brock, "Surface-Soil Properties in Response to Silage Intensity under No-Tillage Management in the Piedmont of North Carolina," presented at the 25th Southern Conservation Tillage Conference for Sustainable Agriculture, Auburn, AL, June 24-26, 2002, at www.ars.usda.gov/SP2UserFiles/Place/66120900/SoilManagementAndCarbonSequestration/2002ajfP02.pdf. The data associated with high intensity crop tillage were used to develop the value used in this analysis.

Preservation Program (FPP).[41] The FPP program provides cost share to establish conservation easements on agricultural lands (up to 50% cost share). As the available data were taken from a 2001 summary for NC, CCS used the high end of the range of costs per acre to represent potential costs in 2007 dollars ($2,069/acre). This cost is nearly identical to the nationwide average determined by the American Farmland Trust ($2,000/acre).[42]

- **Quantification Methods:**

  GHG Benefits

  Studies are lacking on the changes in below and above-ground carbon stocks when agricultural land is converted to developed uses. For some land use changes, carbon stocks could be higher in the developed use relative to the agricultural use (e.g., parks). In other instances, carbon stocks are likely to be lower (graded and paved surfaces). CCS assumed that the agricultural land would be developed into typical tract-style suburban development. It was further assumed that 50% of the land would be graded and covered with roads, driveways, parking lots, and building pads. The final assumption was that 75% of the soil carbon in the top eight inches of soil for these graded and covered surfaces would be lost and not replaced. CCS assumed no change in the levels of above-ground carbon stocks.

  The benefit in each year was determined by: (1) determining the amount of land protected in each year by multiplying the annual rate of agricultural land lost by the percent of agricultural land protected; (2) multiplying the soil carbon content on the protected land by 50% (representing graded and covered areas) and by 75% (fraction of soil carbon lost); (3) converting the soil carbon lost to CO_2 by multiplying by 44/12. Table H-7 provides a summary of the estimates for each year.

[41] NRCS, 2001. Range of Farmland Protection Program costs for easements, range $1,660 - $2,059/acre, average $1,885/acre; Farmland Protection Program, NC Summary, December 2001, at www.nrcs.usda.gov/programs/frpp/StateFacts/NC_2001.pdf.

[42] American Farmland Trust, A National View of Agricultural Easement Programs, at http://www.aftresearch.org/PDRdatabase/NAPidx.htm.

Table H-7. Land Protection Schedule and Associated Benefits

Year	% of Conversion Reduced	Ag Acres Protected	$MMtCO_2e$ Saved
2007	0	0	0.00
2008	10	10,160	0.07
2009	10	10,160	0.07
2010	20	20,320	0.13
2011	20	20,320	0.13
2012	30	30,480	0.19
2013	30	30,480	0.19
2014	30	30,480	0.19
2015	30	30,480	0.19
2016	40	40,640	0.26
2017	40	40,640	0.26
2018	40	40,640	0.26
2019	50	50,800	0.32
2020	50	50,800	0.32
	Totals	**406,400**	**2.6**

Costs

To estimate program costs in each year, CCS used multiplied the estimated agricultural acres protected from development by the conservation cost ($2,069/acre) and an assumed cost share of 50%. This cost share is assumed to be available from the NRCS or other sources (e.g., city or county governments, or non-government organizations). The resulting cost effectiveness is $114/Mt. This estimate only accounts for the direct reductions associated with soil carbon losses estimated above and does not include potentially much larger indirect benefits associated with reductions in vehicle miles traveled (see TLU Option 1a).

Note that the availability of this cost share is a significant assumption for this policy option, since the number of acres to be protected is substantially higher than the average protected during the 1996-2001 period (about 200 acres/year). Without the cost share, the cost effectiveness would be twice the value presented here.

- **Key Assumptions:** No change in above-ground carbon stocks; 75% loss of soil carbon on 50% of developed land; 50% cost share available from NRCS, city/local governments, or other sources.

Key Uncertainties

As described above, these include the estimated above and below ground carbon stocks for agricultural and developed land uses and the availability of cost share programs to offset the costs of purchasing conservation easements.

Additional Benefits and Costs

- **Human and Social Issues:** Protection of working lands will provide a better quality of life for the citizens of North Carolina and protect its rural Landscapes and heritage. Protection of these lands will also help to preserve lands for producing food, fuel and other resources needed by society.
- **Environmental Issues**: (1) Working lands provide environmental services to the citizens of North Carolina by providing clean air, clean water, and wildlife habitat that all North Carolinians enjoy. It has been well documented that impervious surfaces and development has a detrimental affect on our natural resources. (2) The Preservation of working lands can also suppress suburban sprawl and help decrease transportation related emissions.
- **Economic Issues:** (1) Cost of community service studies show that residential development does not pay for itself in taxes. However, working lands require an average of .34 cents in services for every $1 collected from local governments. This is a net gain for local and county budgets (AFT). (2) Agriculture is the #1 industry in North Carolina at $68 billion dollars in total revenue.

Feasibility Issues

None noted.

Status of Group Approval

Complete

Level of Group Support

Unanimous

Barriers to Consensus

None

AFW-4b. Preservation of Working Lands – Forest Land

Mitigation Option Description

Reduce conversion of forest lands to non-forest cover such as development and to reduce the rate at which forested tracts are becoming parcelized and/or fragmented. Developed areas contain lower amounts of biomass and its associated carbon. These areas also sequester less carbon dioxide than forested areas. When landowners don't have the incentive to retain their ownership, they often not only sell for development, but they may sell a forested tract by smaller parcels which may then be too small to allow forest management to be practical. On tracts too small and fragmented to be managed, the goals of AFW 9&10 cannot be achieved. Managed stands sequester carbon faster than non-managed stands. Also, harvested products from managed stands sequester carbon long-term in durable products. Finally, biomass used for energy purposes can offset fossil fuel use.

Mitigation Option Design

North Carolina is losing on average 61,390 acres of productive forest each year over the last 30 years to development and a lack of post-harvest regeneration. This amounts to a loss of about 10% of the state's forestland since 1974, or about a 0.36% annually compounded loss.

- **Goals:** Reduce the rate of conversion by 10% by 2010 and 25% by 2020.
- **Timing:** See above.
- **Parties Involved:** NC Division of Forest Resources, NC Extension, NCSU College of Natural Resources, NC Forestry Association, and NC Woodlands.
- **Other:** The conversion of forested lands to developed uses is not consistent; between 1984 and 1990, there was actually an increase in the timberland area of 260,000 acres. This offers hope that one might reverse the overall trends in forest losses.

Implementation Mechanisms

- Use valuation, perhaps subsidize where use value is same as commercial value.
- Higher value to forestry, see AFW 9 & 10.
- Better funding for existing forest conservation easement programs
- Retain Forestry Present Use Valuation

Related Policies/Programs in Place

- North Carolina Conservation Tax Credit Program
- North Carolina Forest Legacy Program

Type(s) of GHG Reductions

- Prevention of emissions from forest conversions and retention of soil carbon
- Continued forest growth and sequestration on protected acres

- Carbon sequestration in the form of durable wood products and fossil fuel offsets from forest based energy (not quantified)

Estimated GHG Reductions and Costs (or Cost Savings)

- **GHG reduction potential in 2010, 2020 ($MMtCO_2e$):** 1.7, 4.3.
- **Cumulative GHG reduction potential ($MMtCO_2e$, 2007-2010):** 35.5
- **Net Cost per $MtCO_2e$:** $3
- **Data Sources:** US Forest Service Methods for Calculating Forest Ecosystem and Harvested Carbon with Standards Estimates for Forest Types of the US, General Technical Report NE-343 (also published as part of the Department of Energy Voluntary GHG Reporting Program). Data from the USFS Forest Inventory Program were used to determine the average annual rate of forest loss over the last 30 years. North Carolina Conservation Tax Credit Program (http://www.enr.state.nc.us/conservationtaxcredit/pages/creditperformance.html). North Carolina Forest Legacy Program – internal Forest Legacy documents provided by Dr. Mark Megalos and (http://www.dfr.state.nc.us/tending/tending_legacyoverview.htm).
- **Quantification Methods:** Carbon savings were estimated as the portion of carbon that would be lost as a result of forest conversion to developed uses. A carbon savings coefficient was calculated from standard carbon stock coefficients for a 65-yr old loblolly-shortleaf pine stand in the southeastern US (Table H-8). It was assumed that 95% of the carbon stocks would be lost in the event of forest conversion to developed uses with no appreciable carbon sequestration in soils or biomass following development.

Table H-8. Carbon Stocks for 65-year-old Loblolly-Shortleaf Pine in the Southeastern US

Forest Carbon Pool	MtC/acre	MtC/ha
Live tree	40.3	99.6
Standing dead tree	1.2	2.9
Understory	1.2	2.9
Down dead wood	3.3	8.1
Forest floor	5.8	14.4
Soils	28.2	69.6
Total	**79.9**	**197.5**

Source; USFS GTE NE-343, Table B39

Carbon savings were calculated using a gradual phase in of the goal levels. A 2.5% reduction in annual forest conversion rates was assumed in 2007 (i.e., conversion did not occur on 1,535 acres of forests as a result of the program). The number of acres that were not converted to developed uses was increased incrementally by 2.5% per year until 2010, at which point 6,139 acres of forest were maintained instead of being converted to development. From 2010 to 2020, the number of acres of forest not converted each year phases in more gradually (i.e., by 1.5% each year), such that by 2020, 15,348 acres of forest is maintained instead of converted. Each year, the number of acres estimated to

remain in forest as a result of the program was multiplied by 95% of the total carbon stock shown in Table H-8.

Annual carbon savings over the time period 2007-2020 are shown in Figure H-1 and cumulative carbon savings are shown in Figure H-2.

Figure H-1. Annual Carbon Savings

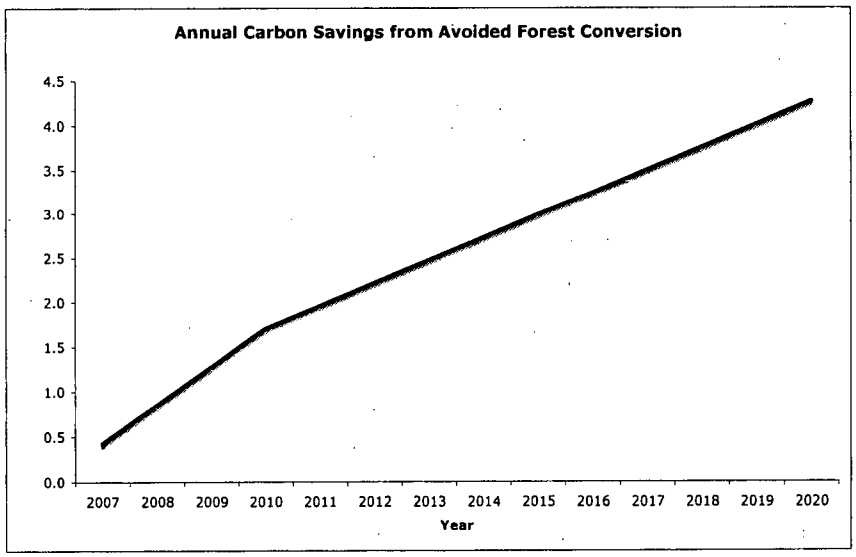
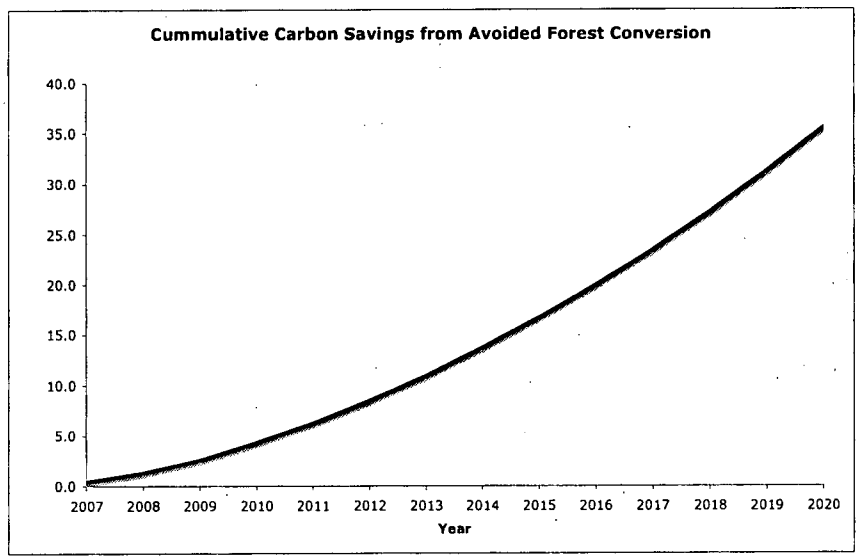


Figure H-2. Cumulative Carbon Savings



The typical cost of conservation easements in North Carolina was used as a basis for the per acre cost of preventing forest conversion. The number of forest acres not converted each year as a result of the program was multiplied by $1,300/acre to get total annual costs each year from 2007-2020. In 2007, annual costs were $1,995,175, rising each year

to a total of $19, 951,750 in 2020. Annual discounted costs were estimated using a 5% interest rate. The cumulative cost effectiveness of the total program was calculated by summing the annual discounted costs and dividing by cumulative carbon sequestration, yielding $3/t$CO_2$e.

- **Key Assumptions:** The analysis assumes that 95% of total forest carbon is lost when forests are converted to developed uses and that no appreciable carbon sequestration occurs post-development. This is based on expert judgment of the TWG that nearly complete removal of biomass and topsoil occurs when land is developed in NC. The analysis does not account for carbon sequestration in harvested wood products, which may enhance carbon savings if forests falling under this option are managed for harvest. For the purposes of the analysis it was assumed that forests are primarily pine types and coefficients for loblolly-shortleaf stands were used.

  The analysis assumes a cost of $1,300/acre, based on data from the NC Forest Legacy Program and the NC Conservation Tax Credit Program. The Forest Legacy Program reports costs of $1,304 - 1,573/ac for the period 2000 to 2005 for 6,500 acres of land conserved. The North Carolina Conservation Tax Credit Program reports an average cost to the state in tax credits of $1,318/acre for 1999 to 2005 for 14,500 acres of land conserved. The cost of $1,300/acre, which is at the low end of the range for the NC Forest Legacy Program was chosen with the rationale that product-oriented forest management on some portion of the lands would add value that could not be explicitly factored into the analysis.

Key Uncertainties

- Whether the amount of land in this analysis would be developed during the period covered, in the absence of this option. A map of lands in the North Carolina Conservation Tax Credit Program (http://www.enr.state.nc.us/conservationtaxcredit/images/ctcp2004.gif) shows lands that are at some risk of development (primarily located in the coastal, Triangle and Triad areas of NC).
- The full range of factors that limit current development easement programs. Funding is a primary limiting factor. Program design is also an issue, for example, lack of term easements (35-50 years) and in some cases the inflexible nature of some easement agreements with regard to forest management/harvesting can limit their application.
- The future value of land prices. They could increase to the point of that these programs will not be cost effective. Easement values will always be less than the total value of the land.

Additional Benefits and Costs

Non-quantified benefits include an improved or maintained quality of life for people near conserved lands as well as wildlife, recreation and watershed improvements.

Feasibility Issues

Better funding of programs to purchase development easements for continued and improved forest management is needed to assure successful implementation of this policy.

Status of Group Approval

Complete

Level of Group Support

Unanimous

Barriers to Consensus

None

AFW-5. Agricultural Biomass Feedstocks for Electricity or Steam Production

Mitigation Option Description

Offset fossil fuel use with agricultural biomass as feedstock for electricity, steam, or heat generation. Agricultural biomass includes, but is not limited to, poultry litter, livestock manure, and crop residues, as well as energy crops (e.g., switchgrass, hybrid poplar). Offsetting fossil fuels use reduces the GHG emissions associated with these fuels.

Note: This option links with AFW-1, which promotes the use of anaerobic digesters and energy utilization. It explores additional opportunities for agricultural biomass energy use. This option also has linkages to ES Options 1 (Renewable Energy Incentives), 2 (Environmental Portfolio Standard), and 10 (NC Greenpower Renewable Resources Program), and to RCI Option 10 (Distributed Renewable and Clean Fossil Fuel Power Generation).

Mitigation Option Design

- **Goals:** Increase agricultural biomass use for electricity, steam, and heat generation to utilize 10% of available biomass by 2010, 25% of available biomass by 2020, and 50% of available biomass by 2030. Voluntary, incentive-based programs should be used to foster development of the industry and associated economic markets.
- **Timing:** See above.
- **Parties Involved:** NCDA&CS, NCSU, NCA&T, Cooperative Extension, NC State Energy Office, DAQ, Utilities Commission, Electric Utilities, Livestock & Poultry Producers, and Crop Producers.
- **Other:** Explore biomass utilization for electricity, steam, and heat generation using 100% biomass and/or co-firing with other feedstocks (as described in the ES and RCI options cited above).

Implementation Mechanisms

- To build a biomass fuel collection and distribution infrastructure, incentives will be needed in the form of tax breaks (sales and/or income) for incurred capital costs for biomass processing and transportation equipment.
- Inclusion/Expansion of voluntary programs such as NC Green Power or other energy production-specific cost share programs.
- Increased research to improve return on investment.
- Education for potential producers of power purchase agreements and interconnection with the grid.
- Public education of benefits of electricity produced from biomass, drive demand.
- Additional research for utilization of available biomass for electricity production.

- Additional research for more efficient biomass processing and delivery for utilization in electricity or heat/steam production.

Related Policies/Programs in Place

- NC Renewable Energy Property tax credit. State income tax credit for 35% of construction costs not to exceed $2.5M or 50% of tax burden.
- Federal Renewable Electricity Production Tax Credit.
- NC Green Power.

Type(s) of GHG Reductions

- **CO_2:** Savings occur as a result of displacing fossil fuel use in the production of electricity or steam.

Estimated GHG Reductions and Costs (or Cost Savings)

- **GHG reduction potential in 2010, 2020 ($MMtCO_2e$):** 0.009, 0.022
- **Net Cost per $MtCO_2e$:** $54.

  Note: The costs and benefits shown above are those associated with in-state biomass feedstock delivery to a power plant or heat/steam end user. The benefit is based on offsetting coal use. The GHG benefits and costs from offsetting fossil-based power or heat/steam generation with biomass generation are covered in the ES and RCI sector. While the costs for purchasing biomass are covered in the ES and RCI sectors, the costs represented here relate to the incentives program needed to develop a biomass collection and distribution infrastructure within the state. Since, the ES-1 and 2 analysis captures fuel lifecycle benefits, the benefits shown above largely overlap with those quantified under the ES options (most of the biomass generated under this option was to be directed to the electricity sector and only a small amount directed to RCI). Accordingly, the benefits shown above, have been removed from the sector totals adjusted for overlap.

- **Data Sources:** Information on available biomass feedstocks was taken from a recent study supporting a renewable portfolio standard in NC.[43] A primary source of information for this study is a 2004 report from the NC Solar Center.[44] Estimates of available agricultural biomass feedstocks are shown in Table H-9.

[43] *Analysis of a Renewable Portfolio Standard for the State of North Carolina,* prepared by La Capra Associates for the NC Utilities Commission, December 2006.

[44] *Use of Agricultural and Forest Waste as a Distributed Generation Power Resource in North Carolina,* NC Solar Center, July 16, 2004.

Table H-9. Estimated Annual Agricultural Biomass Resources

Feedstock	Annual Resource (dry tons)	Annual Resource (MMBtu)
Corn Stover	963,494	14,259,711
Wheat Straw	60,413	942,443
Poultry Litter[45]	50,000	650,000
Switchgrass	263,132	4,210,112
Hybrid Poplar	302,909	5,149,453
Totals	**1,639,948**	**25,211,719**

NOTE: Dairy and beef cattle and hog manure could be an additional biomass resource for this option, but were left out of this analysis to avoid overlap with AFW-1.

- **Quantification Methods:**

GHG Benefits

Since the direct benefits of using biomass energy in place of fossil fuels at the combustion source (e.g. power plant, industrial boiler) are captured in the applicable ES or RCI analysis, the benefits assessment here focused on the incremental GHG benefits associated with fuel delivery. The analysis assumes that biomass will replace coal.

National average emission factors for coal mining/processing and transport were taken from Argonne National Laboratory's GREET model.[46] The sum of these emission factors is 0.0044 $MtCO_2e$/MMBtu of coal delivered. To estimate the emissions associated with delivering biomass in NC, an emission factor of 0.0009 $MtCO_2e$/MMBtu was developed.[47]

The GHG benefit was estimated as the difference between the emissions from coal delivery and biomass delivery. Emissions for each were based on the amount of fuel to be delivered in each year determined from the goals of the policy (2.5×10^6 MMBtu in 2010 and 6.3×10^6 MMBtu in 2020).

Costs

Implementation of this option notes the need for building biomass collection and distribution infrastructure in the state. To address this need, CCS assumes that a five-year incentives program will be needed. The cost of these incentives was estimated as the difference in the

[45] The estimate for poultry litter assumes a broiler population of 100,000,000 in NC and heat content of 6,500 Btu/lb dry solids ("Animal and Poultry Waste-To-Energy", L. Bull, NCSU, at: www.cals.ncsu.edu/waste_mgt/waste%20to%20energy.pdf and litter production of one ton per thousand birds, at www.fibrowattusa.com/US-Press/WattPoultryUSA%20Dec%2001%20on%20Nutrient%20Mgt.pdf. Moisture content of litter is assumed to be 50%. Additional litter produced in turkey or hen/breeder operations not included.

[46] Michael Wang and Ye Wu, Argonne National Laboratory, personal communication with S. Roe, CCS, February 23, 2007.

[47] This emission factor is based on the following data and assumptions: diesel emission factor 10.04 $MtCO_2e$/gal; 23 ton diesel truck fuel consumption - 6 miles/gallon; round trip delivery of 100 miles; biomass has a moisture content of 30%; average heat content of dry biomass is 7,687 Btu/lb.

cost of delivered coal versus the cost of delivered biomass from agricultural residues as estimated by the US DOE ($1.27/MMBtu).[48] The five year program assumes that sufficient demand will be put in place through the ES and RCI renewables options after five years, such that additional incentives for collection and distribution infrastructure are not needed.

- **Key Assumptions:** National average coal emission factors for mining/processing and transport are representative of the coal consumed in NC; the emission factor developed for NC biomass delivery does not include emissions for equipment used for on-site collection/processing of biomass due to a lack of information (the high end of the range of transport radius, 50-miles, was selected to compensate for this lack of data); the cost difference between coal and delivered biomass (national data) are representative for NC and provide a sound basis for the size of the incentives program needed to build collection and transportation infrastructure in the state. All biomass is utilized by the RCI or ES options.

Key Uncertainties

See key assumptions above. Of these assumptions, those associated with the cost and length of the incentives program are the most uncertain. It is also assumed that all of the biomass resource is utilized by the ES or RCI sectors (and the fossil fuel offset benefit remains with those sectors).

Additional Benefits and Costs

- Additional markets for agricultural biomass.
- Economic growth from electricity produced from local feedstocks, rural economy benefits.

Feasibility Issues

- Demand from electric utilities and the RCI sector.

Status of Group Approval

Complete

Level of Group Support

Unanimous

Barriers to Consensus

None

[48] Biomass price differential between agricultural residues and coal from EIA in NEMS biomass supply modeling; $2.50/MMBtu for biomass compared to $1.23 for coal; $2.50/MMBtu represents the price where significant resource potential becomes available; www.eia.doe.gov/oiaf/analysispaper/biomass/table3.html.

AFW-6. Policies to Promote Ethanol Production

Mitigation Option Description

Offset fossil fuel use (gasoline) with production and use of starch-based and cellulosic ethanol. Offsetting gasoline use with ethanol can reduce GHGs to the extent that the ethanol is produced with lower GHG content. Provide incentives for the production of ethanol from crops, forest sources, animal waste, and municipal solid waste.

Note: This option is linked to the TLU biofuels option (TLU-7). That option focuses on mechanisms to increase biofuels consumption in North Carolina. The quantification of benefits and costs for each option takes into account the anticipated GHG reductions to be achieved by each.

Mitigation Option Design

- **Goals:** Several projects are being proposed that would result in the production of 150 million gallons of ethanol annually in North Carolina by 2008. Incentives could increase this amount to a volume equivalent to offsetting gasoline consumption in the state by 10% in 2015 and 25% by 2025. These goals are based on cellulosic ethanol being commercially viable by 2015.
- **Timing:** See above.
- **Parties Involved:** NCDA&CS, Department of Administration, Motor Carrier Enforcement Division, DENR, Department of Commerce, NC Rural Center, NCSU, NCA&T, other state agencies, agricultural associations which represent producers of feedstock, petroleum industry trade groups, and various industry and forestry associations.
- **Other:** Identify incentives that encourage the growing of feedstocks, production of ethanol in North Carolina, and the utilization of ethanol all across the state.
  - Consider impact of expected increases in transportation costs on delivery of feedstocks to processing facilities, and how this effects optimal distribution of production infrastructure.

Implementation Mechanisms

- Incentives in the form of tax breaks (sales and/or income) for incurred capital costs.
- Streamlined permitting of production facilities. Technical assistance for new producers.
- Active solicitation of new producers.
- Expanded consumer education to drive demand.
- Expanded producer education to develop skilled workforce.

- Expanded research for cellulosic ethanol production, including energy-specific crops. Additional research needed to verify that sufficient cellulosic feedstocks are available to sustainably achieve the long-term (post-2020) production goals of this policy option.

Related Policies/Programs in Place

- NC Renewable Energy Property tax credit. State income tax credit for 35% of construction costs not to exceed $2.5M or 50% of tax burden.
- Federal Ethanol Mixture Tax Credit, currently $0.50/gallon.

Type(s) of GHG Reductions

- **CO_2:** Lifecycle emissions are reduced to the extent that ethanol is produced with lower embedded fossil-based carbon than conventional (fossil) gasoline. Feedstocks used for producing ethanol can be made from crops or other biomass, which contain carbon sequestered during photosynthesis (i.e., biogenic or short-term carbon). There are two different methods for producing ethanol based on two different feedstocks. Starch-based ethanol is derived from corn or other starch/sugar crops. Cellulosic ethanol is made from the cellulose contained in a wide variety of biomass feedstocks, including agricultural residue (e.g., corn stover), forestry waste, purpose-grown crops (e.g., switchgrass), and municipal solid waste. Local production of ethanol also decreases the embedded CO_2e of ethanol compared to importation from the current U.S. primary ethanol producing regions. Current research indicates cellulose-based ethanol production provides up to 72-85% reduction in GHGs compared to gasoline, whereas an 18-29% reduction is measured from starch-based ethanol production compared to gasoline.

Estimated GHG Reductions and Costs (or Cost Savings)

- **GHG reduction potential in 2010, 2020 ($MMtCO_2e$):** 0.9, 6.9.
- **Net Cost per $MtCO_2e$:** $5.
- **Data Sources:** In-state production targets were estimated based on the current and projected levels of gasoline consumption (from the GHG Inventory & Forecast), the policy design parameters, and information on BAU ethanol production.[49] The total BAU production (194 MMgal/yr) is based on information gathered from a variety of sources for proposed ethanol plants in NC. The first step in estimating in-state production targets is shown in Table H-10. The estimated in-state production volumes are the volumes needed in each year to show progress toward the 2015 and 2025 policy goals minus the estimated BAU production:

[49] BAU production assumes first phase of Agri-Ethanol Plant in operation - 57 MMgal/yr in 2007; second phase in 2008 - 57 MMgal; E85 Inc. and Clean Burn Fuels also have proposed plants (capacities unknown) - assume another 80 MMgal/yr BAU production in 2008. Total BAU production is 194 MMgal/yr. This value is assumed to remain constant through 2020.

Table H-10. Estimating In-State Ethanol Production Needs

Parameter	2010 (MMgal)	2020 (MMgal)
BAU Gasoline Consumption	5,076	5,764
Ethanol Needed for Policy Targets	193	896
BAU Ethanol Production	194	194
Ethanol Production Needed	0	702
[a] Based on 3.8% gasoline offset by 2010 and 17.5% by 2020 (toward 2025 goal of 25%).		

Since the BAU production meets the levels of production needed for 2010, a different ramp up schedule was set up for incentives in the early part of the policy period (2007-2014) to stimulate production using GHG-superior methods (cellulosic ethanol, starch-based ethanol using renewable energy). The overall production schedule is shown in Table H-11.

Table H-11. Assumed ethanol production schedule (MMgal/yr)

Assumed Ethanol Production Schedule (MMgal/yr)			
2007	–	**2017**	584
2008	10	**2018**	686
2009	60	**2019**	790
2010	110	**2020**	896
2011	160	**2021**	1,026
2012	210	**2022**	1,142
2013	260	**2023**	1,262
2014	310	**2024**	1,384
2015	362	**2025**	1,509
2016	484		

The methods used to estimate GHG reductions and the costs for the policy are provided below.

- **Quantification Methods:**

  GHG Reductions

  The benefits for this option are dependent on developing in-state production capacity that achieves benefits above the levels of existing and planned (BAU) starch-based production in the U.S. (the benefits of using ethanol from starch-based production are already accounted for under TLU-7). Emission factors for reformulated gasoline, starch-based ethanol, and cellulosic ethanol were taken from a General Motors/Argonne National Lab study.[50] These emission factors incorporate the GHG emissions during the entire life cycle of fuel production (e.g., for gasoline: extraction, transport, refining,

[50] *Well-to-Wheels Analysis of Advanced Fuel/Vehicle Systems—A North American Study of Energy Use, Greenhouse Gas Emissions, and Criteria Pollutant Emissions,* General Motors, Argonne National Lab, and Air Improvement Resource, Inc., May 2005.

distribution, and consumption; for ethanol: crop production, feedstock transport, processing, distribution, and consumption). These life-cycle emission factors are referred to as "well-to-wheels" emission factors (see Table H-12 below).

Table H-12. Well-to-Wheels Emission Factors

Fuel	Emission Factor (grams CO_2e/mi)
Reformulated gasoline	552
Starch-based ethanol	451
Cellulosic ethanol	154

In addition to cellulosic ethanol production, the other types of ethanol production processes targeted by this option include starch-based processes that achieve similar levels of life-cycle GHG reductions to cellulosic ethanol. These would be starch-based plants that use renewable fuels, such as biomass, biogas, landfill gas, or other renewable fuels. While CCS is not aware of any lifecycle emission factors for these types of plants (although several have been proposed in the U.S.), CCS assumes that reductions similar to cellulosic ethanol can be achieved.

Based on the emission factors shown above, the incremental benefit of the production targeted by this policy over conventional starch-based ethanol is 66% (reduction of CO_2e by offsetting gasoline consumption). This value was used along with the lifecycle emission factor for gasoline[51] and the production in each year to estimate GHG reductions.

Costs

Costs for the incentives needed by this policy option are based on the difference in estimated production costs between conventional starch-based ethanol and cellulosic ethanol. The DOE EIA estimated that the cost to produce starch-based ethanol is $1.10/gal compared to $1.29/gal, or a difference of $0.19/gal (in $1998).[52] In 2006 dollars, the difference is $0.23/gal. These incentives are considered necessary in the near term (up to 2015) to help commercialize technologies that produce ethanol from cellulose or produce starch-based ethanol using renewable fuels. The incentives should also help to establish the infrastructure to deliver biomass to biorefineries, since producers will seek the local feedstocks or renewable fuels for their operations.

By 2015, it is assumed that advances in cellulosic ethanol production (e.g., enzyme costs, production processes) will make cellulosic ethanol production cost competitive with starch-based production. Hence, the incentives are discontinued beginning in 2015. Note that there is currently federal legislative proposal to offer cellulose an incentive of $0.765/gallon compared to the $0.51/gallon currently offered for ethanol production.[53] If

[51] In the study mentioned above, the average fuel economy used was 21.3 miles/gallon or 100 miles/4.7 gallons. Multiplying this value by the emission factor of 552 grams/mile yields 11,745 grams/gallon.

[52] DOE EIA analysis can be found at www.eia.doe.gov/oiaf/analysispaper/biomass.html, accessed January 2007.

[53] D. Morris, *Making Cellulosic Ethanol Happen: Good and Not So Good Public Policy*, Institute for Local Self-Reliance, January 2007, at www.newrules.org/agri/cellulosicethanol.pdf, accessed January 2007.

enacted, this $0.255/gallon premium could cover the additional incentives that are assumed to be needed by the State of North Carolina. Obviously, the federal incentives do not assure that production facilities would locate in NC. These federal incentives have not been factored into the cost estimates for this option.

The costs for this option were estimated using the $0.23/gal incentive multiplied by the production needed in each year. By 2015, it is assumed that these incentives will no longer be needed as cellulosic ethanol technologies become fully commercialized. Table H-13 contains the assumed schedule for these incentives.

Table H-13. Projected Ethanol Capacity, Incentives Cost, and GHG Benefit: 2007–2020

Year	New Capacity (MMgal)	Incentives Cost (MM 2006$)	GHG Benefit ($MMtCO_2e$)
2007	–	$0.00	0
2008	10	$2.3	0.08
2009	60	$13.8	0.46
2010	110	$25.3	0.85
2011	160	$36.8	1.24
2012	210	$48.3	1.62
2013	260	$59.8	2.01
2014	310	$71.3	2.40
2015	362	$0.0	2.80
2016	484	$0.0	3.74
2017	584	$0.0	4.52
2018	686	$0.0	5.30
2019	790	$0.0	6.11
2020	896	$0.0	6.93

After discounting and leveling the costs from 2007–2020, the cost effectiveness is just under $5/$MtCO_2e$.

- **Key Assumptions:** Starch-based ethanol production using renewable fuels achieves equivalent GHG lifecycle benefits as cellulosic ethanol; cellulosic production or starch-based production with renewable fuels can achieve the production levels in the near term (2014 production of 310 MMgal/yr) required by this policy option; Federal tax incentives do not preclude the need for the additional state incentives assumed for the cost estimate.

Key Uncertainties

These include the assumption that commercial-scale cellulosic ethanol production is viable by 2015. Also, that sufficient biomass feedstocks are available in the state to achieve the levels of production proposed in this policy option (see Feasibility Issues below). Finally, that the level of incentives proposed for this option is sufficient to drive the creation of a sustainable biomass

ethanol production industry in the state (both in terms of feedstock delivery and production facilities).

Additional Benefits and Costs

- Additional markets for starch/sugar crops and possibly dedicated energy crops.
- Economic growth from locally produced fuels.

Feasibility Issues

- Feedstock supply for corn based ethanol production. It is not clear whether additional production beyond that needed to supply the current and planned facilities can be achieved without negatively affecting food and feed crop production.
- Feedstock supply for cellulosic ethanol production: Assuming that all of the new production would come from cellulosic technology, Table H-14 provides estimates of the amount of biomass feedstock needed in each year. These estimates were derived using biomass conversion factors that range from 70 gallons ethanol/ton biomass thru 2011 to 100 gallons/ton by 2020.[54]

Table H-14. Projected Ethanol Capacity and Feedstock Needs: 2007–2025

Year	Ethanol Capacity Needed (MMgal)	Cellulosic Feedstock Needed (tons dry biomass)
2007	–	–
2008	10	142,857
2009	60	857,143
2010	110	1,571,429
2011	160	2,285,714
2012	210	2,333,333
2013	260	2,888,889
2014	310	3,444,444
2015	362	4,020,419
2016	484	5,378,883
2017	584	6,487,503
2018	686	7,619,897
2019	790	8,776,457
2020	896	8,961,825
2021	1,026	10,256,697
2022	1,142	11,422,706
2023	1,262	12,616,196

[54] Source: John Ashworth, National Renewable Energy Laboratory, personal communication with S. Roe, CCS, April 2007. Values used were 70 gallons/ton thru 2011; 90 gallons/ton 2012-2019; and 100 gallons/ton 2020-2025.

Year	Ethanol Capacity Needed (MMgal)	Cellulosic Feedstock Needed (tons dry biomass)
2024	1,384	13,837,169
2025	1,509	15,085,624

Forestry Options 9&10 yield 0.3 and 2.1 MMtons of biomass in 2010 and 2020, respectively. In addition to these biomass resources, two other studies[55] found that there was a potential for 6.4 to 12.0 MMtons of biomass resources in the state (the agricultural biomass resources from AFW-5 are captured in these studies as are purpose-grown energy crops, switchgrass and hybrid poplar, and urban wood waste). Based on these estimates, the resource begins to be fully utilized in the 2018 to 2025 timeframe. More detailed studies of NC biomass resource potential will be needed to verify the availability of feedstocks to achieve the levels of production envisioned by the policy option.

Status of Group Approval

Complete

Level of Group Support

Unanimous

Barriers to Consensus

None

[55] 6.4 MMtons estimated in the following report: National Renewable Energy Laboratory, *A Geographic Perspective on the Current Biomass Resource Availability in the United States,* Technical Report NREL/TP-560-39181, December 2005. 12 MMtons estimated in the following report: *Analysis of a Renewable Portfolio Standard for the State of North Carolina,* La Capra Associates, December 2006.

AFW-8. Afforestation and/or Restoration of Nonforested Lands

Mitigation Option Description

Afforest nonforested lands or restore degraded habitats to forests in order to sequester and store carbon above pre-existing conditions. Existing afforestation programs are underfunded for the task of this afforestation, typically there is a long wait list for landowner forestation projects. This option covers the provision of additional incentives to increase the rate of afforestation and restoration.

Mitigation Option Design

- **Goals:** Initiate afforestation/restoration projects on 540,000 acres by 2020.
- **Timing:** By Fall 2007 planting season have candidate acreage identified (by county) in cooperation with NRCS, FSA and NC SWCD and NC DFR.[56] By 2010, achieve afforestation projects on 40,000 acres. Achieve a total of 540,000 acres of afforestation projects by 2020.
- **Parties Involved:** Seek to establish a unified cooperative alliance of farm (NC Farm Bureau), forest landowner (NC Woodlands, North Carolina Forestry Association), agencies (NC DFR, NC DA), utilities (Duke, Progress Energy), and industrial and non-governmental organizations to promote and implement the coordination needed to reach this historic goal.
- **Other:** Afforestation, the planting of trees on lands that have not recently supported forests, has both carbon sequestration and other environmental benefits—storing over one ton of carbon per acre each year (on-site, not including off-site storage and offsets in products). Afforestation delivers other important benefits such as improved wildlife habitat, reduced soil erosion and fertilizer runoff, and new recreational opportunities. There is a large opportunity for afforestation on agricultural, brownfields, and other lands in NC (possibly greater than 1.5 million acres).[57] These lands are relatively productive for forestry, as the croplands have typically been previously fertilized with mineral nutrients. The average cost-sharing for forestation success in the NC Forest Development Program (FDP) averages between $90 and $200 per acre.[58] The FDP has been the major funding mechanism for state assistance to landowners foresting their lands (~90% of all acres cost shared by currently active NCDFR administered forestation programs[59]) and

[56] Natural Resources Conservation Service & Farm Services Agency (USDA), North Carolina Soil and Water Conservation Districts and Division of Forest Resources.

[57] Conservation Compliance: the Clock is Running. Cook, M. and D. Hoag. 1997 SoilFacts, AG-439-23, at http://www.soil.ncsu.edu/publications/Soilfacts/AG-439-23/. Accessed 10/3/2006.

[58] Forest Development Program, Annual Accomplishment Summary, 2006, Joann Hocut, NC Division of Forest Resources.

[59] Ibid.

has reached approximately 85% of NIPF landowners doing forestation over the last 6 years (1999-2005).[60]

Implementation Mechanisms

An Afforestation Task Force comprised of the Parties Involved would advise North Carolina Division of Forest Resources regarding an enhanced Forest Development Program, which will additionally target agricultural lands. The cost share rates would be 100% of establishment costs (only seedlings, planting, and herbicide the first year) plus $200 of rent payments over 5 years which would be expected from a CRP type program. The overall cost to the state per acre of afforestation is about $340. Program and salary costs for 3 foresters to implement this program would be about $200,000 annually.

Bioenergy markets can increase demand for energy plantations, and potentially influence afforestation/reforestation rates in NC.

Related Policies/Programs in Place

Federal Conservation Reserve Program
Federal Conservation Reserve Enhancement Program
North Carolina Agriculture Cost Sharing Program
North Carolina Forest Development Program

Type(s) of GHG Reductions

- Carbon sequestration from new forest growth
- Sequestration in durable wood products and fossil fuel offsets from forest based energy (not quantified, outside of analysis period)
- Prevention of emissions from forest conversions and improved retention of soil carbon over agriculture (included in AFW 7)

Estimated GHG Reductions and Costs (or Cost Savings)

- **GHG reduction potential in 2010, 2020 ($MMtCO_2e$):** 0.2, 2.4
- **Cumulative GHG reduction potential ($MMtCO_2e$, 2007-2010):** 15
- **Net Cost per $MtCO_2e$:** $9
- **Data Sources:** US Forest Service Methods for Calculating Forest Ecosystem and Harvested Carbon with Standards Estimates for Forest Types of the US, General Technical Report NE-343 (also published as part of the Department of Energy Voluntary GHG Reporting Program). NC Division of Forest Management, Forest Development Program (Joann Hocutt), cost share rates.
- **Quantification Methods:** The amount of carbon sequestration achieved over time as a result of afforesting 40,000 acres by 2010 and 500,000 acres from 2010 to 2020 was quantified using carbon sequestration coefficients in Table H-15.

[60] Chris Hopkins' synthesis of Forest Statistics for North Carolina, 2002 and FDP reports.

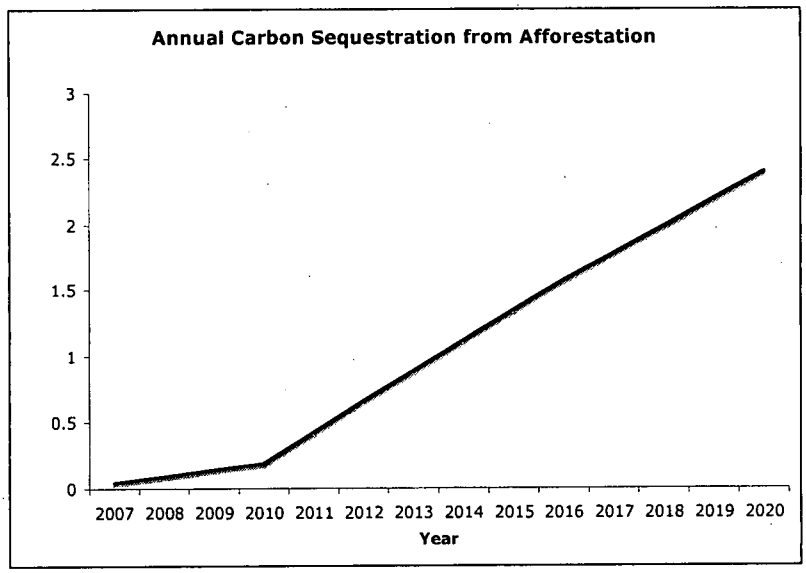
Table H-15. Carbon Sequestration Rates for Loblolly-Shortleaf Pine in the Southeastern US (Tons per Acre and Hectare)

Stand age	tC/acre/yr	tC/ha/yr
0–5	1.28	3.16
5–15	1.12	2.77

Source; USFS GTE NE-343, Table B39

Carbon sequestration was calculated annually, assuming afforestation rates of 10,000 acres/yr (4,045 ha/yr) from 2007-2010 and 50,000 acre/yr (20,225 ha/yr) from 2011-2020. Annual carbon sequestration was calculated separately for stands age 0-5 yrs and 5-15 yrs and summed for an annual total. Annual carbon sequestration as a result of afforestation over the time period 2007-2020, under full implementation of the goals outlined above, are shown in Figure H-3. Figure H-4 shows the cumulative total carbon sequestration over the same time period.

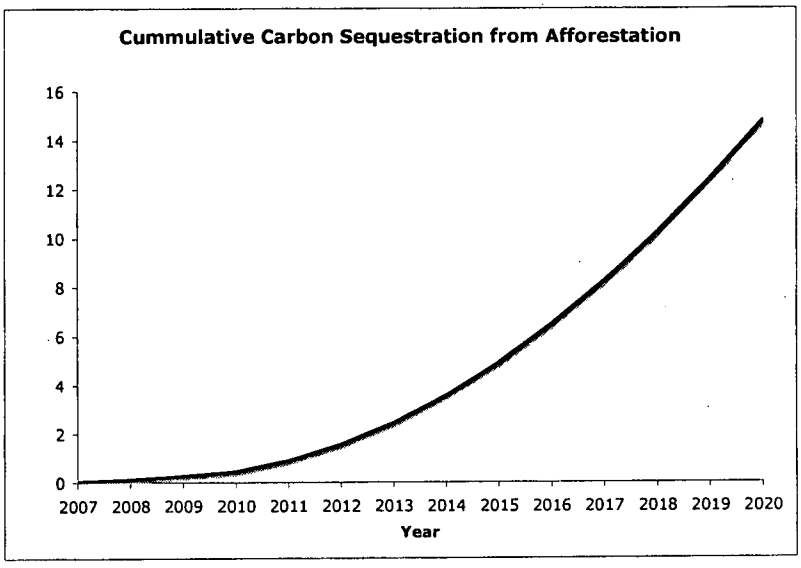
Figure H-3. Annual Carbon Sequestration



The cost of afforestation was estimated as an expense of $340/acre (see key assumptions) multiplied by the number of acres planted each year plus $200,000 per year for other program costs (i.e., forestry staff). Afforestation costs from 2007-2010 were $3,600,000/yr and costs from 2011-2020 were $17,200,000/yr. Annual discounted costs were estimated using a 5% interest rate. The cumulative costs effectiveness of the total program was calculated by summing the annual discounted costs and dividing by cumulative carbon sequestration, yielding $9/Mt$CO_2$e.

- **Key Assumptions:** All planted forests were assumed to be primarily pine dominant stands. The cost per acre was assumed at $340/acre based on 100% cost share rates for establishment (seedlings, planting, and herbicide the first year) plus $200 of rent payments over 5 years, which would be expected from a CRP type program. An additional program cost covering salary for 3 foresters to implement this program was assumed at $200,000 annually.

Figure H-4. Cumulative Carbon Sequestration



Key Uncertainties

Whether landowners with unforested land be willing to accept a new form of land management that may be unfamiliar and has a different investment structure than agriculture.

The rent payments of $40 per acre per year for 5 years is shorter than the duration of CRP program payments which are usually 10 years; we believe this will be sufficient for North Carolina, but this is not certain

Additional Benefits and Costs

Non-quantified benefits include an improved or maintained quality of life for people near conserved lands as well as wildlife and watershed improvements.

Feasibility Issues

Better funding of the Forest Development Program to plant forests is feasible given adequate program funding.

Status of Group Approval

Complete

Level of Group Support

Unanimous

Barriers to Consensus

None

AFW-9 & 10. Expanded Use of Forest Biomass and Better Forest Management

Mitigation Option Description

Through proven and accepted forest management practices, increase forest stand productivity and then direct that productivity into the highest-value markets that currently exist. Move the unmarketable logging residue, culls and saplings to the appropriate processing centers for electricity, heating or liquid fuels. Offsetting fossil fuel use reduces GHG emissions. Increase the growth and yield of production from sustainably managed forest resources through site preparation, competition control, thinning, fertilization, and improved genetics. These practices will increase the amount of carbon stored in forested areas and increase carbon dioxide sequestration rates.

Mitigation Option Design

The goal is the expansion of the production and use of wood products for solid wood products, fiber, and fuel. Such use offsets fossil fuel burning in the production of substitute materials (e.g., cement or steel for solid wood products, and plastic for wood fiber). Wood can subsitute for fossil fuels directly in the case of biomass for energy. However these GHG benefits are not explicitly included in the analysis, which focuses on direct carbon sequestration in forests and in wood products. Having a market for relatively low-value biomass products enables forest management for higher-value solid wood products. (See Additional Benefits and Costs section below for more background.)

- **Goals:** Initiate programs to increase forest productivity by 100% on half of NC timberlands by 2020.
- **Timing:** Begin 2007 and increase to full implementation of management programs on 50% of timberlands by 2020
- **Parties Involved:** Division of Forest Resources, NCSU Extension, NC Forestry Association, and NC Woodlands, NCSU, College of Forest Resources
- **Other:** The goal is to double the productivity of timberland for high value products and claim these products and energy as carbon offsets. We estimate that 1.75% (~57 year rotation) of the state timberland (totaling 17.6 million acres) is cut each year, so most timberland is currently under some sort of management, although much of it is of a very low intensity, indeed 25% of harvested stands continue to be high-graded. Our goal is to improve the management and productivity of these lands, especially on the 11.4 million acres held by non-industrial, private-forest landowners.

Implementation Mechanisms

Enhanced funding of the North Carolina Forest Development Program. The full funding level to accomplish program goals would be approximately $230 million annually.[61] This program should include 10% of the budget reserved for forestry extension activities to help educate and

[61] Current program funding levels average $2.6 million per year over the last several years.

motivate forest landowners and professional foresters to better manage their lands and to make the overall program more cost effective.

Improve markets for low value energy wood through the Renewable Environmental Portfolio Standard legislation.

Recognition and ability to trade carbon credits from both standing forests and harvested wood products.

Related Policies/Programs in Place

North Carolina Forest Development Program

Type(s) of GHG Reductions

- Carbon sequestration in forest ecosystems and durable wood products
- Fossil fuel offsets from forest based energy (GHG benefits accounted for elsewhere, i.e., in AFW-6 and in RCI and ES sectors)
- Prevention of emissions from forest conversions and improved retention of soil carbon (not quantified)

Estimated GHG Reductions and Costs (or Cost Savings)

- **GHG reduction potential in 2010, 2020 ($MMtCO_2e$):** 1.5, 5.9.
- **Cumulative GHG reduction potential ($MMtCO_2e$, 2007-2010):** 48
- **Net Cost per $MtCO_2e$:** -$13
- **Data Sources: :** US Forest Service Methods for Calculating Forest Ecosystem and Harvested Carbon with Standards Estimates for Forest Types of the US, General Technical Report NE-343 (also published as part of the Department of Energy Voluntary GHG Reporting Program). US Forest Service Forest Inventory Program. Annual Survey of Manufactures (2005). NC Division of Forest Management, Forest Development Program (Joann Hocut), Forest Statistics for North Carolina 2002.
- **Quantification Methods:** There are two parts to this analysis. The first quantifies the impact of the program on forest carbon (i.e., carbon in living and dead biomass and in soils within the forest ecosystem) and the second quantifies the impact on carbon removed from the forest as durable wood products. The starting point for both parts of the analysis is the same. The Forest Inventory Analysis (FIA) database from the US Forest Service was queried to determine forest productivity (cubic feet of harvested volume) and area of timberlands in North Carolina for the most current year available (2002). Productivity and area data were classified into two categories, pine-dominant forest types and all other forest types (most of which contain oak species) (Table H-16)

Table H-16. Baseline Forest Productivity in North Carolina (FIA, 2002)

Forest Type	Area (acres)	Productivity (cubic feet)	Productivity per area (cubic ft/acre)
Pine (all pine dominant types)	4,960,656	8,483,024,291	1,710
Oak (all other types)	12,716,225	21,841,789,468	1,718

Forest ecosystem carbon sequestration was estimated using average annual carbon sequestration coefficients in Table H-17. Coefficients for pine-dominant stands were based on carbon sequestration rates in Loblolly-shortleaf pine stands in the Southeastern US and coefficients for all other forests were based on carbon sequestration in Oak-hickory forests in the Southeastern US (USFS GTR NE-343). Separate coefficients were available for average and high productivity Loblolly-shortleaf pine stands. Coefficients for improved productivity Oak-hickory stands were not available and thus were estimated by assuming increased rates of carbon sequestration equivalent to 50% of the increases reported for the high productivity Loblolly-shortleaf pine stands.

Table H-17. Forest Ecosystem Carbon Sequestration Coefficients for North Carolina

	Pine (average productivity)	Pine (high productivity)	Oak (average productivity)	Oak (high productivity)*
Stand age		Carbon Stocks (MtC/ac)		
0	40.16	44.41	26.84	27.46
90	90.00	96.56	89.84	91.92
Avg. annual carbon sequestration (tC/ac/yr)	0.55	0.58	0.70	0.71

* USFS does not provide high-productivity carbon values for Oak forest types in the Southeast. These values were calculated by assuming a 2.3% increase in carbon sequestration, which is half the percent increase reported by the USFS for Pine.

Source: USFS GTR NE-343, Tables A39, A40, A44

Baseline annual carbon sequestration was calculated by applying the average productivity coefficients in Table H-17 to the forest areas in Table H-16 each year from 2009-2020. To calculate carbon sequestration under program implementation, the forest areas achieving high and average productivity each year were modeled for the time period of 2009-2020. Under program implementation, forest treatments to improve productivity were assumed to begin in 2007. By 2009, high levels of productivity would be realized on 10% of the targeted area split equally between Pine and Oak classes (total targeted area is 50% of all NC timberland, or 8,838,441 acres). Each year, the area of forests at high productivity levels was increased by 10% until the full goal level was achieved in 2018. Total forest area was held constant each year.

High productivity and average productivity carbon sequestration coefficients were applied to the relevant forest area estimates each year to calculate forest carbon sequestration under program implementation. Baseline levels were subtracted to calculate the incremental increase in carbon sequestration as a result of the program. The results are shown in Table H-18.

Table H-18. Summary of Forest Area and Forest Carbon Sequestration from 2009-2020 (under baseline and program implementation)

Year	High productivity forests (ac)	Average productivity forests (ac)	Carbon sequestration under the program (MMtC/yr)	Baseline carbon sequestration MMtC/yr)	Carbon sequestration above baseline (MMtC/yr)
2009	883,844	16,793,037	11.66	11.65	0.02
2010	1,767,688	15,909,193	11.68	11.65	0.03
2011	2,651,532	15,025,349	11.70	11.65	0.05
2012	3,535,376	14,141,505	11.71	11.65	0.07
2013	4,419,220	13,257,661	11.73	11.65	0.08
2014	5,303,064	12,373,817	11.75	11.65	0.10
2015	6,186,908	11,489,973	11.76	11.65	0.12
2016	7,070,752	10,606,129	11.78	11.65	0.13
2017	7,954,597	9,722,285	11.80	11.65	0.15
2018	8,838,441	8,838,441	11.81	11.65	0.17
2019	8,838,441	8,838,441	11.81	11.65	0.17
2020	8,838,441	8,838,441	11.81	11.65	0.17

Forest sequestration in harvested wood products (HWP) was calculated following guidelines published by the US Forest Service. Details on each step of the analysis can be found in the guidelines, following the methodology referred to as "Land-based estimation." In general, forest productivity is used as a starting point and regional patterns in the disposition of carbon through various HWP pools are used to model carbon stock changes in HWP over time. The methodology calculates the transfer of carbon through four pools over time: wood in use (i.e., building materials, furniture), wood in landfills (i.e., products that were previously in use and have been discarded), wood burned for energy capture, and wood that has decayed or burned without energy capture. The difference in the amount of carbon entering the "in use" and "landfill" pools at the beginning of a year and the amount remaining one year later equals total net annual carbon flux in HWP.

For this analysis, carbon sequestration in HWP was compared under baseline and program implementation levels. Baseline levels of carbon sequestration in HWP were calculated using forest productivity values in Table H-16 and default coefficients for pine and oak forest types and for the southeast region. Two modifications were made to estimate carbon sequestration under program implementation. First, productivity levels were gradually increased as described above for the analysis of forest ecosystem carbon. Second, the disposition pattern was modified such that 10% less wood was disposed in landfills and instead shifted to use for energy production, thus providing more feedstocks for bioenergy. In both cases, the annual area harvested in NC was assumed to be 317,800 acres (Forest Statistics for NC, 2002).

The results of the analysis are summarized in Table H-19, which show the amount of carbon stored in landfills and products in-use each year above what would have happened in the baseline, spanning the time period 2009-2020. While the amount of additional carbon in landfills and in products from a given harvest decreases each year (as it is emitted through decay or energy capture), additional wood is harvested each year and at increasing levels of productivity. Thus for every year in the time series, the carbon stocks in the wood products pool are increasing. This analysis is carried out until 2020 and does not capture the continued disposition of carbon through the wood products pools in time.

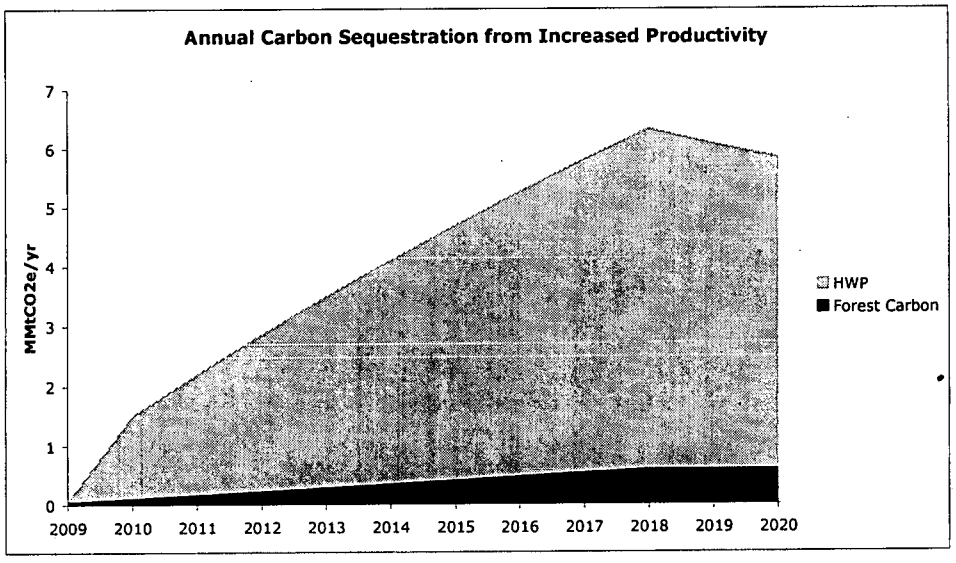
An alternative approach for estimating carbon stored in wood products is to estimate the amount of carbon remaining in products and landfills after 100 years and apply that value to the year of harvest (GTR NE-343, 1605b technical guidelines). This approach accounts for emissions that would occur over 100 years following harvest in the year of the harvest, and assumes that the carbon remaining after 100 years is stored permanently. This approach was developed to simplify annual reporting of carbon stored in wood products and to account for the long term dynamics of carbon flows in harvested wood products pools. For comparison to the analysis covering 2009-2020, the amount of carbon above baseline levels that would be stored in products and landfills 100-yrs after harvest is shown in the last column of Table H-19. The total carbon still stored in HPW from harvests that occurred during 2009-2020, after 100 years is 5.15 MMtC (compared to the cumulative carbon stored in HWP during 2009-2020, of 11.93 MMtC).

Table H-19. Disposition of Carbon Stored in Landfills and in Products over Time (amount is additional carbon above baseline levels)

Year of harvest	Carbon from the harvest in yr x (x=row) that is in use or landfill by the end of year y (y=column) (MMtC)												
	2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**100 yrs later**
2009	0.19	0.18	0.17	0.16	0.16	0.15	0.14	0.14	0.13	0.13	0.12	0.12	0.07
2010		0.39	0.37	0.35	0.33	0.31	0.30	0.29	0.28	0.27	0.26	0.25	0.14
2011			0.58	0.55	0.52	0.49	0.47	0.45	0.43	0.42	0.40	0.38	0.21
2012				0.78	0.73	0.69	0.66	0.63	0.60	0.57	0.55	0.53	0.27
2013					0.97	0.92	0.87	0.82	0.78	0.75	0.72	0.69	0.34
2014						1.17	1.10	1.04	0.99	0.94	0.90	0.86	0.41
2015							1.36	1.28	1.21	1.15	1.10	1.05	0.48
2016								1.56	1.46	1.38	1.31	1.25	0.55
2017									1.75	1.65	1.56	1.48	0.62
2018										1.95	1.83	1.73	0.69
2019											1.95	1.83	0.69
2020												1.95	0.69
Carbon stored in HWP in year y (MMtC)	0.19	0.57	1.12	1.84	2.71	3.73	4.90	6.20	7.64	9.20	10.69	12.13	5.15
Annual Carbon Sequestration (MMtC/yr)	0.00	0.38	0.55	0.71	0.87	1.02	1.17	1.30	1.44	1.56	1.49	1.43	

Figure H-5 shows the combined estimated GHG reductions from forest carbon and HWP.

Figure H-5. Annual Carbon Sequestration



There are also emissions reductions associated with the displacement of fossil fuels by bioenergy generated from the additional biomass feedstocks resulting from forest productivity enhancements. Under this option, an estimated 15 MMt more biomass would be used for bioenergy from harvests during 2009-2020.

The cost of management treatments to increase productivity was estimated at $8.80/ac/yr multiplied by the number of acres treated each year (see Table H-18 for annual area of high productivity forests). Revenue from the additional harvested wood products generated from productivity treatments was also taken into consideration. The value of additional wood products harvested during 2028-2037 as a result of productivity treatments during 2009-2020 was calculated assuming a future value of $389.90/ac (a present value $119.14/ac). If productivity is doubled on a total of 8,842,200 acres of forestland during 2009-2020, this gives a net present value (NPV) of $1.05 billion in wood products. The combined NPV of the above costs and cost savings were summed for a total NPV of -$639 million (cost savings). Annual discounted costs and cost savings were estimated using a 5% interest rate. The total NPV was divided by cumulative carbon sequestration, yielding a cumulative cost effectiveness of -$13.21/$tCO_2e$.

- **Key Assumptions:** Productivity increases were assumed to be distributed equally between pine and oak forest types; cost of productivity treatments were assumed at $8.80 per acre per year over 30 years, based on NC Forest Development Program cost-share rates for a one site preparation and planting, three fertilization treatments, and one pre-commercial timber stand improvement. The added value of revenue generated from increased forest productivity was estimated at $390 per acre. The analysis assumes no change in total forest area over the period of analysis.

Key Uncertainties

The silviculture of doubling forest growth is relatively well understood. The key questions involved are centered on feasibility of addressing all targeted land. Will 50% of forest landowners be willing to intensify their forest management with the full range of stand improvement and fertilization foreseen by this program? This may require new forms and levels of public outreach not previously practiced by forestry institutions.

Success of this mitigation option is heavily dependent on the expansion of markets for forest products including lumber and bio-fuels. Future housing markets are not predictable and it remains to be seen the degree to which wood-based renewable energy will be adopted. Use of wood for electricity production will be dependent on regulation and/or incentives. Technologies for cellulosic ethanol are still under development for commercial scale production. And, the future for all renewables is largely dependent of future fossil fuel prices.

Additional Benefits and Costs

Increased benefits from forest management would increase forestland owner incomes and the probability of retaining land in forest cover.

Feasibility Issues

NCDFR personnel have indicated they can substantially increase implementation of FDP with landowners given increased funding, but a many-fold increase in this program will require a large and unknown administrative and on-the-ground personnel demand. The Forest Development Program may not be funded at levels high enough to fully support this program. Other complimentary mechanisms of support may be necessary.

A standard application of fertilizer on otherwise unmanaged land can increase average productivity about 66% for hardwood and 77% for softwoods. Improved genetics continues to add 5 to 10% in productivity for each improved generation. Improved thinning and competition control can increase high value product growth by 20%. The logging residue that currently is left in the woods is about 15% of total productivity and this too would be increased by fertilization and could be used for biomass energy. While not all improvements are directly multiplicative, it is clear that we can double forest productivity and more than double carbon sequestration by forests in North Carolina. If goal levels were extended into the future, productivity could be doubled on all managed timberlands by 2030.

Status of Group Approval

Complete

Level of Group Support

Unanimous

Barriers to Consensus

None

AFW-11. Landfill Methane and Biogas Energy Programs

Mitigation Option Description

Provide incentives that will result in an increase in the recovery of landfill methane for use as an energy source. Increasing the recovery of landfill methane will reduce emissions of this GHG and will offset the use of fossil fuels for commercial/industrial heat/steam generation or electricity production.

Note: This option has linkages to ES Options 1 (Renewable Energy Incentives), 2 (Environmental Portfolio Standard), and 10 (NC Greenpower Renewable Resources Program), and to RCI Option 10 (Distributed Renewable and Clean Fossil Fuel Power Generation).

Mitigation Option Design

Out of approximately 130 open and closed landfills in the state, only about 15 sites are currently recovering landfill methane for energy use.

- **Goals:** Increase the number of uncontrolled municipal solid waste landfills recovering methane as an energy source, such that 50% of the landfill gas being generated is controlled by 2020. This can be done through development of additional landfill gas to energy (LFGTE) projects. For sites where LFGTE is not feasible, implement flaring controls to achieve the goal.
- **Timing:** By 2010, implement LFGTE at 10 sites not currently using these technologies; by 2020, achieve full implementation of the policy (50% coverage of generated LFG).
- **Parties Involved:** Municipal and county governments, private solid waste management companies, local economic development agencies, NC Department of Environment and Natural Resources, NC Department of Commerce, NC Utilities Commission, non-government organizations, and public interest groups.
- **Other:** No distinction is made between the direct use of landfill methane (e.g., for heat or steam) and the use of methane for electricity generation.

Implementation Mechanisms

- Undertake a GIS-based assessment of landfill gas to energy project potentials focusing on identifying end-users (may have been undertaken by NC Solar Center and State Energy Office). Work with the NC Department of Commerce to use the findings for economic development purposes.
- Establish and expand tax credits for the development of landfill gas to energy projects.
- Develop policies that encourage state agencies to enter into fuel/power purchasing agreements that will result in increased landfill gas to energy projects.
- Research the potential to alleviate burdens associated with the NC Utilities Commission rules regarding the treatment of landfill gas to energy projects as regulated utilities.

- Develop a grant program or other incentives to encourage the installation of gas collection systems at landfills for the purpose of flaring landfill methane.

Related Policies/Programs in Place

- NC State Energy Office, NC DENR, NC Solar Center, US EPA – Landfill Methane Outreach Program.
- US Department of Energy, Renewable Energy Production Incentive; US Internal Revenue Code, Section 45; 15 NCAC 13B Section .1500, Standards for Special Tax Treatment of Recycling, and Resource Recovery Equipment and Facilities.

Type(s) of GHG Reductions

Methane Destruction: Flaring or production of energy from landfill gas results in the destruction of methane.

GHGs Reduced via Fossil Fuel Reductions: Use of landfill gas for generating heat/steam or electricity can offset fossil fuel use (e.g., natural gas, coal), which will reduce emissions of CO_2, CH_4, and N_2O from the combustion of fossil fuels.

Estimated GHG Reductions and Costs (or Cost Savings)

- **GHG potential in 2010, 2020 ($MMtCO_2e$):** 1.1, 2.9
- **Net Cost per $MtCO_2e$:** $1

  Information available from the RCI TWG indicates that Option RCI-10 will consume some landfill gas as part of the renewable energy portfolio. The benefit associated with this consumption of an equivalent amount of natural gas (to be claimed under the RCI option) is 0.002 $MMtCO_2e$ in 2010 and 0.007 $MMtCO_2e$ in 2020. These values were subtracted out as overlap in the Summary Table on page 1 of this appendix.

- **Data Sources:** The NC GHG Inventory & Forecast was used as the source of data on available methane emissions. Cost information from EPA's Landfill Gas Cost Model (LFGcost), version 1.4 was used to estimate costs.[62]
- **Quantification Methods:** *GHG Savings.* GHG savings were estimated by determining the CO_2 equivalent for the available methane to be reduced in 2010 (20%) and 2020 (50%) at uncontrolled landfills in the state.[63]

  Additional GHG reductions are achieved by offsetting fossil fuel that would have been used to create the thermal energy or electricity generated by these landfill gas projects. These reductions are provided as part of the LFG cost output and were added to the

[62] Four different runs of LFG cost were provided by A. Singleton, ERG, to S. Roe CCS, March 2007, based on the scenarios specified in the quantification methods section of this option.

[63] The 20% value in 2010 is assumed based on the goal of implementing projects at 10 of about 100 uncontrolled sites. These first sites are likely to be implemented at the largest (highest producing) sites. Based on emissions modeling conducted by CCS during the development of the Inventory & Forecast, implementing projects at 10 of the largest uncontrolled sites would cover at least 20% of the waste in place at these sites and the potential methane emissions.

reductions associated with methane collection and destruction. The total benefits for each year are shown in Table H-20.

Costs

Costs were estimated by applying EPA's LFGcost-web Model (version 1.4) to three different scenarios. The parameters for these scenarios are shown below. These three scenarios were designed to capture the range of costs likely to be seen in NC to apply LFG capture and utilization projects to both uncontrolled and flared landfills. Data to support these three scenarios

Table H-20. Three Landfill Gas Control Options Modeled

Scenario	1	2	3
Current Controls	None	None	Collection & Flare
Year Landfill Opened	1988	1988	1983
Year Landfill Closed	2010	2010	2017
Annual Waste Acceptance Rate (tons)	38,000	38,000	88,000
Landfill Size (acres)	100	100	200
Technology Employed	Small Engine/ Generator Set	Direct Use (heat or steam)	Engine/ Generator Set
LFGcost Value of Energy Produced	$0.045/kWh	$4.50/MMBtu	$0.045/kWh
Modeled Costs	$2.72	-$0.82	$0.15

The data in Table H-20 show that the direct use option results in a net savings (project revenues greater than costs), while the small and standard engine/generator set options result in net costs. Direct use is typically only cost effective when the landfill is within a short radius to the end user (usually a half mile or less). Hence, the opportunities for direct use are limited. Standard engine/generator set projects (800 kW and greater) are used at projects with moderate to large methane production (48 MM cubic feet/year collected on average). Small engine/generator set projects are applicable at smaller sites.

To develop an overall cost for this policy option, CCS used the following assumptions on the mix of projects that would be implemented to achieve the policy's goals: 17% of methane reduced via standard engine/generator set projects (17% of the EPA Landfill Methane Outreach Program database waste in place is at flared sites, which could be candidates for these projects); 20% of methane is controlled by direct use projects (number of projects assumed to be limited by location of end users); and the remaining 63% is assumed to be controlled by small engine/generator set projects.

Using this blend of LFG energy projects and the LFG cost output data, a blended cost effectiveness estimate of $1.57/MtCO$_2$e was estimated. This cost effectiveness estimate was applied to the emission reductions to be achieved in each year by the policy to estimate costs in each year.

CCS did not include the effects of the Section 45 Tax Credit for production of renewable energy, since this credit may or may not be available to many of the projects that would be installed due to this policy. Inclusion of this tax credit would have a small effect at lowering the costs for the policy. For example, the cost effectiveness for the small

engine/generator set option would decrease from the $2.72/Mt estimate shown above to $2.46/Mt.

Information available from the RCI TWG indicates that Option RCI-10 will consume some landfill gas as part of the renewable energy portfolio. The latest estimates are 40 billion BTUs of LFG in 2010 and 138 billion BTUs in 2020. The benefit associated with the offset of an equivalent amount of natural gas (to be claimed under the RCI option) is 0.002 $MMtCO_2e$ in 2010 and 0.007 $MMtCO_2e$ in 2020. These were subtracted at the bottom of the Summary List of Mitigation Options on page 1 to account for this overlap.

- **Key Assumptions:** For this analysis, available methane means 75% of the methane emitted at uncontrolled landfills, which is the assumed amount that can be captured for energy use. Available methane also includes methane being flared at sites with collection and flaring. In 2010, projects are implemented to capture 20% of the available methane; in 2020 this rises to 50%. For costs, the key assumptions are the value of energy produced: $0.045/kWh for electricity projects and $4.50/MMBtu for direct use projects. Higher values for these energy products could reduce the costs of this option significantly.

Key Uncertainties

See Key Assumptions in the section above.

Additional Benefits and Costs

Additional benefits include reducing landfill gas emissions of volatile organic compounds, including some that are hazardous air pollutants.

Feasibility Issues

The practice of locating landfills in very rural areas often results in a lack of viable local end users. Furthermore, the possible treatment as a regulated utility can also prevent landfill gas to energy projects from being developed.

Status of Group Approval

Complete

Level of Group Support

Unanimous

Barriers to Consensus

None

AFW-12. Increased Recycling Infrastructure and Collection

Mitigation Option Description

Increase the quantity of materials recovered for recycling with specific attention given to materials with the greatest ability to reduce energy consumption during the manufacturing process and to materials that may be used as a fuel source (e.g., clean wood waste). Reducing the quantity of materials being put in landfills reduces future landfill methane emissions potential, while recycling reduces emissions associated with the manufacturing of products from raw materials.

Mitigation Option Design

- **Goals:** Increase per capita recovery in the state 25% by 2020.
- **Timing:** Achieve a 10% increase in per capita recovery by 2010 and a 25% increase in per capita recovery by 2020.
- **Parties Involved:** Municipal and county government, private solid waste and recycling management companies, commercial, industrial and institutional generators, and NC Department of Environment and Natural Resources.
- **Other:** For the purpose of calculating per capita recovery, yard waste (yard trash as defined in G.S. 130A-290) and other vegetative debris are not included. Yard waste is banned from disposal in MSW and C&D landfills and experiences large annual fluctuations in both generation and recovery.

Implementation Mechanisms

Numerous options exist for increasing recovery in the state. These options should be thoroughly researched to determine the effectiveness of the various options.

Expand statewide waste reduction education campaigns to include the GHG mitigation benefits of increased waste reduction.

Research the feasibility and impacts of implementing statewide disposal bans for corrugated cardboard and clean wood waste. Make recommendations based on findings.

Conduct extensive research into increased pre-consumer and post consumer food waste diversion[64] covering at a minimum: infrastructure needs, barriers to increasing infrastructure,

[64] Pre-consumer food waste is the easiest to compost. It is simply the preparatory food refuse and diminished quality bulk, raw material food that is never seen by the consumer. This food waste is generally already separated from the rest of the waste stream generated, thus no change is needed to keep contaminants out of the future compost. Post-consumer food waste is more challenging because of separation issues. It is simply the table scrap food refuse. Often, after the consumer is done with the food, the waste is subject to contaminants and a decision has to be made on how to separate the food from other waste. This can be done by having an extra trash can that is only used for food waste.

incremental cost of food waste diversion and potential climate change benefits of food waste diversion. Make recommendations based on findings.

Provide technical assistance to local governments on operating more effective recycling programs (ongoing).

Lead by example for state agencies.

Legislative actions:

- Require any new host community agreements between a landfill developer and any local government to include provisions for a minimum prescribed level of recycling services within a maximum allowable service area per recycling drop-site.
- In lieu of, or in addition to existing local per capita waste reduction goals; requires local government 10-year solid waste management plans to include an enforceable per capita recovery goal that increases annually until 2020. Enforceability may be achieved by requiring local governments to take specific actions to improve performance if goals are not met. An initial minimum recovery rate would have to be determined.
- Increase funding to the NC Solid Waste Management Trust fund for increased grants to local governments and to private sector for additional infrastructure expansion.

Related Policies/Programs in Place

State Solid Waste Management Trust Fund, NC Division of Pollution Prevention and Environmental Assistance (DPPEA) – Community Waste Reduction and Recycling Grants, Recycling Business Development Grants; Local Government Assistance Team, NC DPPEA; Recycling Business Assistance Center, NC DPPEA.

GS 130A-309.10(f) and (f1) – Materials Banned from Disposal and Incineration.

GS 130A-309.09A – Local Government Solid Waste Responsibilities.

Type(s) of GHG Reductions

Landfill Methane: Reducing the quantity of organic material entering the anaerobic environments found in landfills will result in a decrease in methane gas releases from landfills.

Upstream Energy Use Reductions: Less energy is generally required to manufacture goods from recycled feedstocks than from virgin feedstocks. For example, the addition of recycled glass cullet to the glass making process allows manufacturers to operate furnaces at lower temperatures.

Estimated GHG Reductions and Costs (or Cost Savings)

- **GHG potential in 2010, 2020 ($MMtCO_2e$):** 0.20, 0.49.
- **Net Cost per $MtCO_2e$:** $1.

  EPA's Waste Reduction Model (WARM)[65] was used to estimate the emissions associated with the State's current level of recycling and with the goal of increasing recycling by

65 Version 7, August 2005. From http://www.epa.gov/climatechange//wycd/waste/calculators/Warm_home.html. EPA created the Waste Reduction Model (WARM) to help solid waste planners and organizations track and voluntarily report greenhouse gas emissions reductions from several different waste management practices. WARM

25% per capita. WARM is based on a life-cycle approach, which reflects emissions and avoided emissions upstream and downstream from the point of use. As such, the emission factors provided in WARM provide an account of the net benefit of recycling and source reduction actions to the environment.

- **Data Sources:** WARM input data for both the baseline and policy scenarios were provided by the NC Division of Pollution Prevention and Environmental Assistance.[66] WARM is provided by the EPA and can be accessed along with documentation at the website listed in the footnotes to this option.
- **Quantification Methods:** Two different runs of the WARM model were conducted. The first was done to represent the current levels of recycling in the state and the associated GHG emissions and reductions. The second was done to represent emissions and reductions associated with increasing the current level of recycling by 25% per capita. Table H-21 summarizes the results of both model runs:

Table H-21. Analysis Results Using WARM

WARM Run	Total GHG Emissions ($MtCO_2e$)
Baseline (without existing recycling)	6,379,586
Baseline (with recycling)	4,439,516
25% Recycling Increase Above Baseline	3,952,224
GHG Reductions	**487,292**

The 2020 reductions is determined as the difference in emissions estimated for the baseline (with existing recycling programs) and the emissions estimated for the 25% increase in recycling run. For 2010, the reduction was estimated using a factor of 0.4 multiplied by the 2020 benefit (10/25, since a 10% per capita recovery is the policy goal for 2010).

Table H-22 provides the WARM output for the 25% increase in per capita waste recycling. The following waste types are small quantities in NC and were excluded from modeling in WARM: motor oil, oil filters, antifreeze, lead-acid batteries, textiles, and mixed C&D recovery. Since these waste types were left out, recycling for all of the other commodities was increased by just over 26% to mimic a 25% increase in per capita recovery. All commodities were increased by the same percentage. In reality, one would

is available both as a Web-based calculator and as a Microsoft Excel spreadsheet. WARM calculates and totals GHG emissions of baseline and alternative waste management practices—source reduction, recycling, combustion, composting, and landfilling. The model calculates emissions in metric tons of carbon equivalent (MtCE), metric tons of carbon dioxide equivalent (MtCO2E), and energy units (million BTU) across a wide range of material types commonly found in municipal solid waste. For explanation of methodology, see the EPA report: *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks* (EPA530-R-02-006), at http://epa.gov/climatechange/wycd/waste/SWMGHGreport.html.

[66] Jim Hickman, NC Division of Pollution Prevention and Environmental Assistance and NC AFW TWG, personal communication and WARM spreadsheets provided to S. Roe, CCS, January 2007.

expect to see a differential increase that would likely result in more fiber recovery by percentage increase. No distinction was made between construction & demolition (C&D) waste and municipal solid waste (MSW). All of the waste was lumped together as mixed MSW. Yard waste was also left out of the modeling. It is banned from disposal in C&D and MSW landfills in NC (it can be mulched, composted or sent to LCID landfills (a.k.a. stump dumps).

Table H-22. WARM Output for the 25% Increase in Recycling Run

Material	Incremental Recycling (Tons)	Incremental GHG Emissions from Recycling ($MtCO_2E$)	Incremental Landfilling (Tons)	Incremental GHG Emissions from Landfilling ($MtCO_2E$)	Total Incremental GHG Emissions ($MtCO_2E$)
Aluminum Cans	1,464	(21,855)	(1,464)	(56)	(21,912)
Steel Cans	1,981	(3,548)	(1,981)	(76)	(3,624)
Copper Wire	0	0	0	0	0
Glass	11,573	(3,238)	(11,573)	(445)	(3,683)
HDPE	1,871	(2,628)	(1,871)	(72)	(2,700)
LDPE	0	0	0	0	0
PET	2,927	(4,548)	(2,927)	(112)	(4,660)
Corrugated Cardboard	28,994	(79,455)	(28,994)	(17,019)	(96,474)
Magazines/third-class mail	819	(2,214)	(819)	185	(2,029)
Newspaper	38,794	(135,448)	(38,794)	31,095	(104,353)
Office Paper	694	(1,722)	(694)	(1,573)	(3,295)
Phonebooks	0	0	0	0	0
Textbooks	0	0	0	0	0
Dimensional Lumber	7,770	(19,058)	(7,770)	3,038	(16,020)
Medium Density Fiberboard	0	0	0	0	0
Food Scraps	NA	NA	0	0	0
Yard Trimmings	NA	NA	0	0	0
Grass	NA	NA	0	0	0
Leaves	NA	NA	0	0	0
Branches	NA	NA	0	0	0
Mixed Paper, Broad	476	(1,508)	(476)	(250)	(1,757)
Mixed Paper, Resid.	10,049	(31,857)	(10,049)	(4,237)	(36,094)
Mixed Paper, Office	0	0	0	0	0
Mixed Metals	25,383	(184,436)	(25,383)	(975)	(185,411)
Mixed Plastics	21	(31)	(21)	(1)	(32)

Material	Incremental Recycling (Tons)	Incremental GHG Emissions from Recycling ($MtCO_2E$)	Incremental Landfilling (Tons)	Incremental GHG Emissions from Landfilling ($MtCO_2E$)	Total Incremental GHG Emissions ($MtCO_2E$)
Mixed Recyclables	1,437	(4,122)	(1,437)	(401)	(4,523)
Mixed Organics	NA	NA	0	0	0
Mixed MSW	NA	NA	0	0	0
Carpet	0	0	0	0	0
Personal Computers	289	(712)	(289)	(11)	(723)
Clay Bricks	NA	NA	0	0	0
Aggregate	0	0	0	0	0
Fly Ash	0	0	0	0	0
Total	134,539	(496,379)	(134,539)	9,088	(487,291)

Columns associated with source reduction, waste combustion, and composting were removed from this WARM output table, since these management practices were not considered in the modeling.

Costs

Information on typical landfill tipping fees, current households served by curbside recycling, households not served by curbside recycling, and the costs for adding curbside recycling services and public education were provided by the NC Office of Pollution Prevention & Environmental Assistance:[67]

- Tons of municipal solid waste diverted by 25% per capita increase: about 134,000;
- Average Landfill tipping fee: $35 ton (conservative estimate, as communities served by transfer stations could pay up to $40/ton);
- Households currently served by curbside recycling: 1,384,653;
- Households not receiving curbside service in towns w/ populations of 5,000 or more: 516,941 (community size is assumed to be the minimum for cost effective recycling services);
- Estimated cost of enhancing education and/or adding more materials to what is already collected in areas receiving curbside recycling: $0.60 per household per year; and
- Estimated cost (based on state averages) for adding curbside collection: $27 per household per year.

The cost for enhancing existing programs is: 1,384,653 households x $0.60 = $830,792/yr.

[67] Jim Hickman, NC Office of Pollution Prevention & Environmental Assistance, personal communication with S. Roe, CCS, January 2007.

The cost of adding programs is: 516,941 households x $27.00 = $4,239,884/yr.

For a total cost of: $5,070,676/yr.

The avoided costs of disposal are: 134,000 households x $35.00 = -$4,690,000/yr.

Resulting in a net cost of $380,676/yr.

From the annual cost above and the estimated GHG reductions estimated with WARM, a discounted and levelized cost effectiveness of $1/MtCO$_2$e was estimated.

- **Key Assumptions:** Within WARM, the following modeling options were selected: (1) material that is source reduced comes from current mix of recycled/virgin materials, not 100% virgin material; (2) NC landfills recover landfill gas at the national average of recovery; (3) landfill gas that is recovered is used for energy recovery, not flared; (4) landfill gas collection system efficiency is 75%; and (5) default distances for materials delivery to management facility were used (20 miles).

Key Uncertainties

See "Key Assumptions" in the previous section

Additional Benefits and Costs

Reduction in other air and water pollutant emissions associated with product manufacturing and transport.

Feasibility Issues

Some legislative action would be required (see Implementation Mechanisms section). Some infrastructure development might be required.

Status of Group Approval

Complete

Level of Group Support

Unanimous

Barriers to Consensus

None

AFW–13. Urban Forestry Measures

Mitigation Option Description

Urban forest cover protection and management offers a potentially cost effect mechanism to reduce energy use, to store/sequester carbon and mitigate land use change (conversion of forest and agricultural lands to residential sites). Strategic planting of trees to shade houses and AC units can yield energy savings of 15% to 50% on cooling costs.[68] Planting of shade trees can reduce summer heating costs, with only marginal increases in winter heating costs, particularly in mild climates. In addition, depending on local conditions, tree planting can reduce wind-speed and further reduce energy costs. The net direct impacts of tree planting are generally estimated to be positive, taking these factors into account.

Mitigation Option Design

- **Goals:** Increase urban tree cover by planting three additional trees (i.e., three more than planned) on all new construction sites starting in 2008, and by planting three new trees on 25% of existing housing units in 2007 by 2020, with the aim of achieving a 25% reduction in annual heating and cooling costs.
- **Timing:** see above.
- **Parties Involved:** Local government planning agencies, developers, residential and commercial property owners, North Carolina Urban Forest Council, DENR Division of Forest Resources, electricity providers, NC Cooperative Extension Service.
- **Other:** Research on cost savings from urban tree planting indicates that planting three additional trees around a housing unit yields cost savings on the order of $150/yr for the southeast (EPA Cooling our Communities). Annual residential energy expenditures on heating and cooling are estimated at $585/yr per housing unit in NC (NC State Energy Plan 2003). Therefore, planting three additional trees amounts to about a 26% reduction in household heating and cooling costs.

Implementation Mechanisms

- Use incentives to encourage developers to retain trees and green space on new construction sites. (Incentives could include density credits, priority during approval/permitting process, utility credits, etc.). Require developers to retain a minimum of 10% canopy cover and those that retain more than that receives increased credits and priority.
- Promote the creation of proper tree preservation and protection ordinances in communities across the state.

[68] Cooling Our Cities, U.S. Environmental Protection Agency PM-221.

- Provide recognition to communities that increase their canopy cover percent (e.g., with CO_2 credits). Allow municipalities and or homeowners to direct benefits of CO_2 sequestration via trees to their budget or charity of their choice, respectively.
- Install green roofs on state buildings – green roofs reduce urban heat islands by providing shade and the cooling effects of evapotranspiration, absorb air pollution, collect airborne particulates, and store carbon, and insulate a building from extreme temperatures (reducing energy costs).
- Support the use of consulting arborists by developers/contractors in the planning and review process prior to building permit submission.
- Empower to NC Division of Forest Resources to increase seedling availability to Urban Tree planting on public lands. Expand the interaction with community groups and environmental organization
- Enhance existing programs (e.g., Neighborwoods, through the Alliance for Community Trees ACT) to educate and cost-share on encouraging seedlings for urban or residential plantings on private home ownerships
- Increase level of support/education to municipalities in order to ensure proper maintenance and care of increased urban forest.
- Designate an Urban Forestry Extension specialist to NCSU Forestry Extension staff

Related Policies/Programs in Place

North Carolina Urban Forest Council
America the Beautiful Program
The Urban and Community Forestry Grant Program
Trees Across Raleigh
Trees Across Asheboro
Quality Forward

Type(s) of GHG Reductions

- Increased carbon sequestration in urban trees
- Avoided emissions by reduced energy use in heating and cooling
- Improved retention of soil carbon (not quantified)
- Carbon sequestration in the form of durable wood products and fossil fuel offsets from forest based energy (not quantified)

Estimated GHG Savings and Costs per $MTCO_2e$

- **GHG reduction potential in 2010, 2020 ($MMtCO_2e$):** 1.4, 4.3
- **Net Cost per $MtCO_2e$:** -$11
- **Data Sources:** Cooling Our Cities, U.S. Environmental Protection Agency PM-221; "Shade trees reduce building energy use and CO_2 emissions from power plants," H. Akbari, Environmental Pollution, Vol. 116, p. S119-S126 March 2002; US Forest Service Effects of Urban Forests and their Management on Human Health and Environmental

Quality (http://www.fs.fed.us/ne/syracuse/Data/data.htm); US Census Bureau statistics on housing units in NC.

- **Quantification Methods:** GHG reductions were quantified separately for (1) carbon sequestration in trees and (2) decreases in residential energy consumption. Trends in US Census Bureau data on housing stocks in North Carolina from 1939-2005 were used to model the NC housing stock from 2007-2020. Since 1938, there was positive growth in housing stock nearly all years, with growth rates ranging from 0.8%/yr during1980-1989 to 11%/yr during 1995-1998. However, growth in housing stock decreased after 1998 and, on average, was -6.5%/yr during 2000-2005. Growth in annual housing stock from 2007-2020 was calculated by assuming 72,454 new housing units were constructed in 2006 (based on the average number constructed per year from 2000-2005) and a -6.5%/yr growth rate for 2007-2020.

  Under the first goal, three additional trees beyond what would normally be planted around new construction in NC are planted on 100% of new housing units every year from 2007-2020. Carbon sequestration in urban trees was assumed at 6 kg C/tree/yr, which is the average for North Carolina in the USFS assessment of urban forest resources (Nowak et al., 2001). Total annual carbon sequestration was calculated each year, including sequestration in trees planted that year and trees planted prior to that year under the program. The results are shown in Table H-23.

Table H-23. Carbon Sequestration in Trees Planted on New Housing Units, 2007–2020

Year	New Housing Units	Number of trees planted	C sequestered in new trees (kg C)	C sequestered in trees planted since 2007 (kg C)	Total CO_2e sequestered ($MMtCO_2e$)
2007	67,751	203,253	1,219,515.93		0.004
2008	63,353	190,059	1,140,356.40	1,219,515.93	0.009
2009	59,241	177,723	1,066,335.16	2,359,872.32	0.013
2010	55,395	166,186	997,118.69	3,426,207.48	0.016
2011	51,800	155,399	932,395.10	4,423,326.17	0.020
2012	48,437	145,312	871,872.76	5,355,721.27	0.023
2013	45,293	135,880	815,278.96	6,227,594.02	0.026
2014	42,353	127,060	762,358.70	7,042,872.98	0.029
2015	39,604	118,812	712,873.53	7,805,231.68	0.031
2016	37,033	111,100	666,600.46	8,518,105.21	0.034
2017	34,630	103,889	623,331.02	9,184,705.67	0.036
2018	32,382	97,145	582,870.22	9,808,036.69	0.038
2019	30,280	90,839	545,035.75	10,390,906.91	0.040
2020	28,314	84,943	509,657.14	10,935,942.66	0.042

Under the second goal, three additional trees are planted on 25% of the 2007 housing stock over the course of 2007-2020. NC housing stock in 2007 was estimated at

4,080,759 units based on US Census Bureau data. The analysis assumed gradual implementation such that three trees were planted on 72,871 units each year. By 2020, three additional trees were planted on a total of 1,020,190 units (25% of 2007 housing stock). Total annual carbon sequestration in these trees was calculated each year, including sequestration in trees planted that year and trees planted prior to that year under the program. The results are shown in Table H-24.

Table H-24. Carbon Sequestration in Trees Planted on Existing Housing Units, 2007–2020

Year	# Units Planted	Number of trees planted	C sequestered in new trees (kg C)	C sequestered in trees planted since 2007 (kg C)	Total CO_2e sequestered ($MMtCO_2e$)
2007	72,871	218,612	1,311,672		0.005
2008	72,871	218,612	1,311,672	1,311,672	0.010
2009	72,871	218,612	1,311,672	2,623,345	0.014
2010	72,871	218,612	1,311,672	3,935,017	0.019
2011	72,871	218,612	1,311,672	5,246,690	0.024
2012	72,871	218,612	1,311,672	6,558,362	0.029
2013	72,871	218,612	1,311,672	7,870,035	0.034
2014	72,871	218,612	1,311,672	9,181,707	0.038
2015	72,871	218,612	1,311,672	10,493,380	0.043
2016	72,871	218,612	1,311,672	11,805,052	0.048
2017	72,871	218,612	1,311,672	13,116,725	0.053
2018	72,871	218,612	1,311,672	14,428,397	0.058
2019	72,871	218,612	1,311,672	15,740,070	0.063
2020	72,871	218,612	1,311,672	17,051,742	0.067

GHG reductions from avoided use of fossil fuels for heating and cooling were also estimated. Reductions in energy consumption were based on energy cost savings from tree planting. Research on cost savings from urban tree planting indicates that planting three additional trees around a housing unit yields cost savings on the order of $150/yr/household for the southeast (EPA Cooling our Communities). Annual residential energy expenditures on heating and cooling are estimated at $584.60/yr per housing unit in NC (NC State Energy Plan 2003). Therefore, planting three additional trees amounts to about a 26% reduction in household heating and cooling costs. It was assumed that at 26% reduction in costs translated into a 26% reduction in annual electricity and natural gas consumption for residential heating and cooling.

In NC, about 52.9 and 26.7 million BTU's (MMBTU) of electricity and natural gas, respectively, are used for heating and cooling per household (NC State Energy Plan 2003). It was assumed that housing units that planted trees under the program reduced electricity and natural gas consumption by 13.75 and 6.94 MMBTUs per year, respectively. Electricity and natural gas emission factors (0.1578 and 0.0528 tonnes CO_2e/MMBTU, respectively) were calculated from the NC Inventory and Forecast (the electricity emission factor was modified based on additional data from the electricity

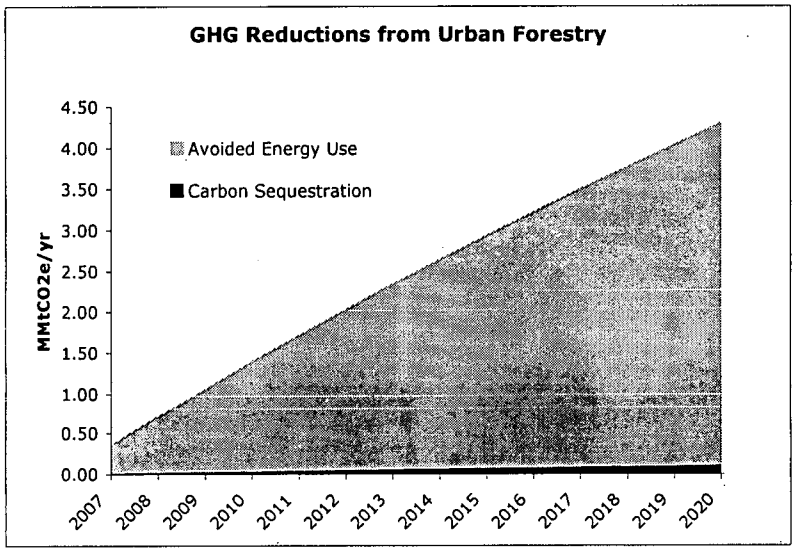
sector in NC, as documented in the ES Methods Memo). The resulting GHG emission reductions are shown in Table H-25.

Table H-25. GHG Reductions from Reduced Use of Fossil Fuels for Household Heating and Cooling

Year	Housing units with additional trees	Energy Reductions-electricity (MMBTU)	Energy Reductions - natural gas (MMBTU)	CO_2e reductions-electricity ($MMtCO_2e$)	CO_2e reductions-natural gas ($MMtCO_2e$)	Total Reductions ($MMtCO_2e$)
2007	140,622	1,934,109	976,195	0.31	0.05	0.36
2008	276,845	3,807,732	1,921,861	0.60	0.10	0.70
2009	408,957	5,624,794	2,838,979	0.89	0.15	1.04
2010	537,223	7,388,967	3,729,403	1.17	0.20	1.36
2011	661,894	9,103,684	4,594,865	1.44	0.24	1.68
2012	783,202	10,772,155	5,436,986	1.70	0.29	1.99
2013	901,366	12,397,382	6,257,280	1.96	0.33	2.29
2014	1,016,590	13,982,172	7,057,164	2.21	0.37	2.58
2015	1,129,064	15,529,150	7,837,964	2.45	0.41	2.86
2016	1,238,968	17,040,771	8,600,918	2.69	0.45	3.14
2017	1,346,469	18,519,328	9,347,185	2.92	0.49	3.42
2018	1,451,721	19,966,970	10,077,847	3.15	0.53	3.68
2019	1,554,871	21,385,701	10,793,917	3.38	0.57	3.95
2020	1,656,056	22,777,399	11,496,343	3.59	0.61	4.20

The relative contribution of tree carbon sequestration and reductions in energy consumption to overall GHG reductions is shown in Figure H-6. Reductions in avoided use of fossil fuels for heating and cooling makes up most of the reductions over the time series.

Figure H-6. GHG Reductions



Urban tree planting has both costs and cost savings. The cost of planting and maintaining urban trees was estimated by multiplying the number of trees planted each year by $250/tree. The cost is based on a reported range of $10-500 per tree (Akbari 2002). The range reflects variation in program implementation and consideration of full life cycle costs (i.e., pruning/maintenance, liability, waste disposal, etc.). The value of $250/tree is near the midpoint of this range. (The reported range does not consider potential uses of biomass waste for energy purposes, neither does this analysis.) In addition, cost savings was estimated by multiplying the cumulative number of households in the program each year by $150/yr/household. Net annuals costs (costs minus cost savings) are initially positive. However, starting in 2011, as more households see cost savings from reduced heating and cooling requirements, costs become increasingly negative. Annual discounted costs were estimated using a 5% interest rate. The cumulative costs effectiveness of the total program was calculated by summing the annual discounted costs and dividing by cumulative carbon sequestration, yielding -$11/ton CO_2e.

- **Key Assumptions:** Future growth of housing stocks is assumed at 6.5%/yr, starting with 4,080,759 existing units in 2007. Three additional trees per household will reduce heating and cooling costs by $150/yr. Costs of planting and maintaining urban trees is $250/tree. Average tree carbon sequestration in urban trees is 6 kg C/tree/yr.

Key Uncertainties

The cost effectiveness of urban tree planting for carbon sequestration is not in doubt. The impact of hurricanes on shade trees is important, but uncertain in timing and spatial distribution. The biggest question is the administration of this program to reduce the cost of planted trees. The ability to implement these programs in smaller and newer communities[69] may be limited by administrative capacity in these communities.

[69] Predominantly in former agricultural lands without trees, although many new communities on former forest land completely clear all original trees.

Additional Benefits and Costs

Additional benefits include an improved or maintained quality of life for people in improved urban forests as well as wildlife, recreation and watershed improvements.

Feasibility Issues

Urban forestry is in general a known field with appreciable positive impacts.

Status of Group Approval

Complete.

Level of Group Support

Unanimous.

Barriers to Consensus

None.

Real and Verifiable Carbon Offsets

North Carolina Legislative Commission on Global Climate Change

December 4, 2007

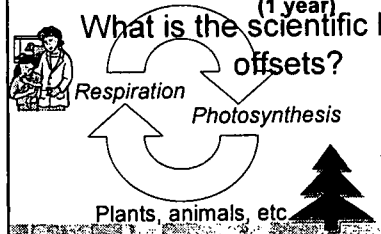
Bill Chameides, Dean
Nicholas School of the Environment
Duke University

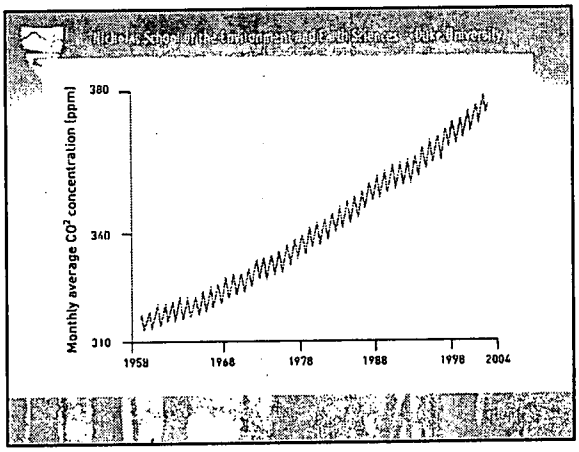
What are offsets?

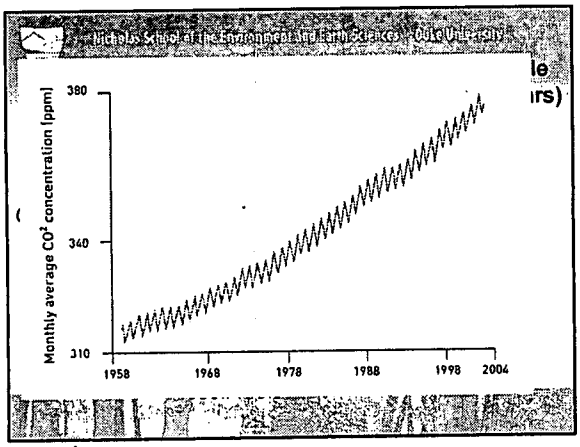
- Actions that remove or prevent the emissions of greenhouse gases in one location
- And are used to "offset" an equivalent amount of emissions at another location
  - > Land Management Practices

We have upset the natural balance: Earth's carbon cycle

What is the scientific basis for offsets?



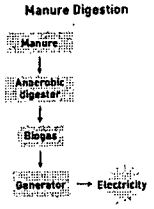




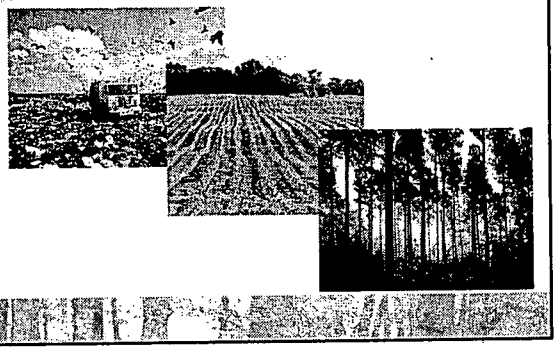
Land-management offsets: Examples

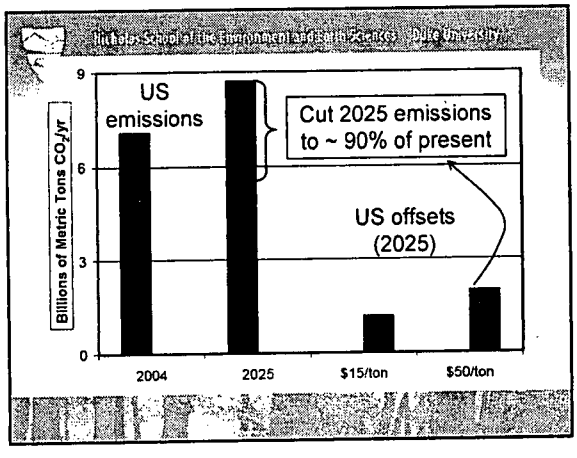
- Capture methane emissions from manure, land fills, etc





Land-management offsets: Examples





So…

- Offsets represent a huge opportunity
- But also the potential for a huge problem:
  - How do we know that a given offset is "*real*?"

Offsets

- Huge potential to advance climate mitigation.
- But also huge potential to frustrate climate mitigation if the offsets are not real.

Offsets Have Been Getting Some Bad Press

The Economist
Another stab at carbon offsets



THE WALL STREET JOURNAL.
An Inconvenient Pool

BusinessWeek
Another Inconvenient Truth



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FINANCIAL TIMES

Wednesday April 25, 2007 USA $1.00 Canada C$2.00

CO2 needs a price but taxes are the best way to set it

Editorial Comment

The Kyoto protocol to fight climate change expires in 2012. The shape of a successor treaty is still in doubt, but one aspect seems certain: carbon trading will play a major role. A Financial Times investigation today reveals that carbon markets leave much room for unverifiable manipulation. Taxes are better, partly because they are less vulnerable to such improprieties.

Climate change poses a classic spill-over problem: individuals do not suffer the full burden of producing carbon dioxide, but society does. To equate the private cost to the higher social cost, governments can create markets for carbon, by using tradeable optimal method of auctioning permits, governments have given them away. It is no wonder that energy producers are keen to participate in these schemes.

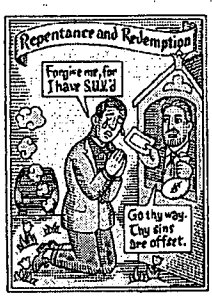
While short-term politics favour markets, taxes would be better in the long term, because industry needs certainty for investments years hence. A government committing to painful taxes signals the seriousness of its intentions.

Carbon taxes, offset by cuts in other taxes, are more difficult to eliminate than artificial markets.

Carbon markets have other problems. Above all, they fix the amount of while markets in emission quotas create unnecessary certainty about the short-term quantity of emissions.

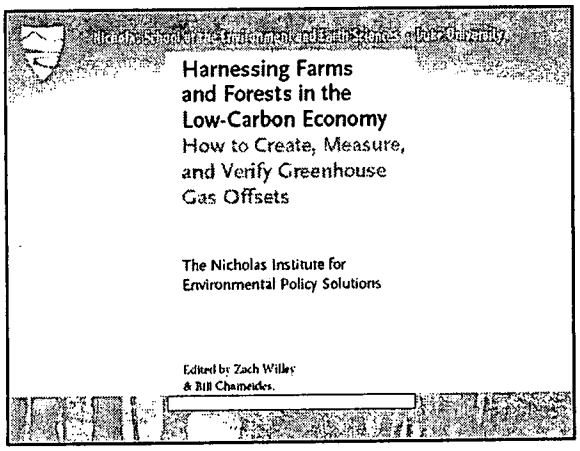
Both carbon taxes and markets put undue burden on the poor. Governments should counter such regressive carbon taxes by lowering taxes on labour. Yet most of the political appeal of markets is that they hide the true costs to consumers. That is why carbon markets exist in the first place. For this reason it is unlikely that governments would offset the invisible burden of markets by changing visible taxes.

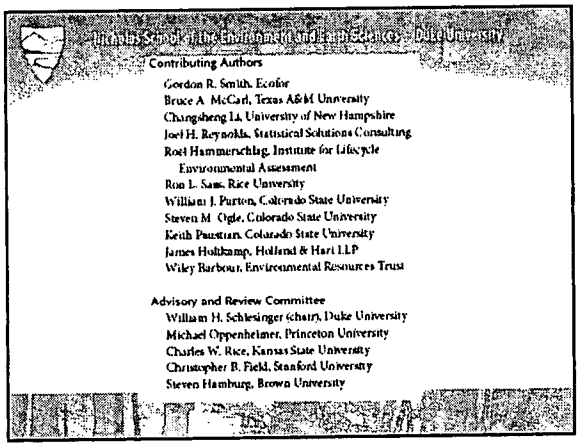
Smart market design could overcome most problems with tradeable permits: price caps could prevent undue harm

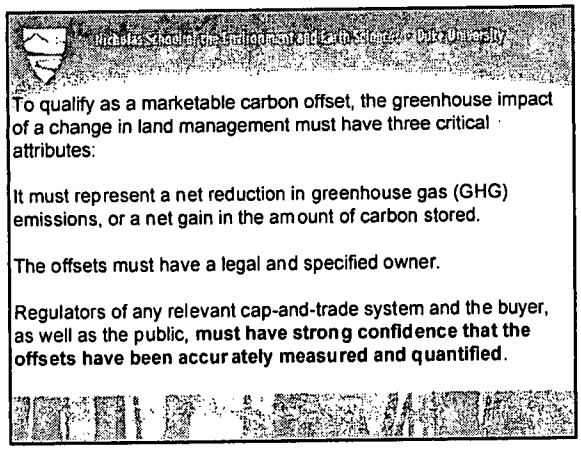


Offsets must be credible

That's why the scientific community has developed a "gold standard" for offsets.


Harnessing Farms
and Forests in the
Low-Carbon Economy
How to Create, Measure,
and Verify Greenhouse
Gas Offsets
The Nicholas Institute for
Environmental Policy Solutions
Edited by Zach Willey
& Bill Chameides.


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To qualify as a marketable carbon offset, the greenhouse impact of a change in land management must have three critical attributes:
It must represent a net reduction in greenhouse gas (GHG) emissions, or a net gain in the amount of carbon stored.
The offsets must have a legal and specified owner.
Regulators of any relevant cap-and-trade system and the buyer, as well as the public, must have strong confidence that the offsets have been accurately measured and quantified.

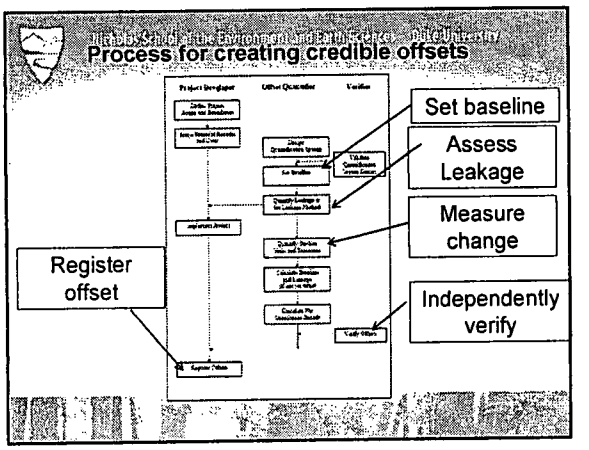
Projects Considered

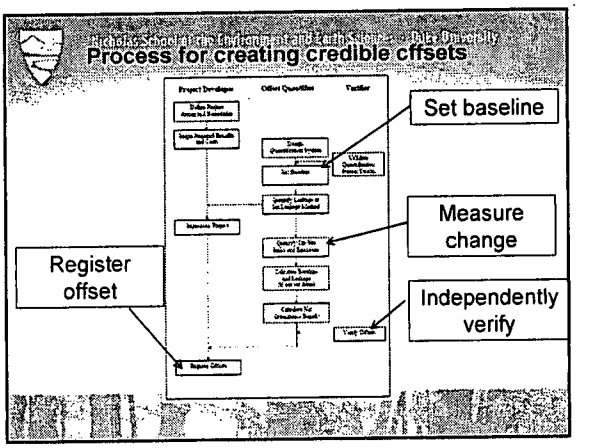
>Sequester carbon in biomass through the cultivation of new forests and grasslands, or delays in the harvesting of forests.

>Sequester carbon in soils through changes in farming practices, such as through the adoption of no-till farming.

>Reduce greenhouse emissions of methane through changes in the practices used to process and dispose of manure.

>Reduce greenhouse emissions of methane and nitrous oxide through changes in farming practices.





Summary

- Offsets can play a significant role in the new C economy
  - But only if they are quantified, independently verified and registered
  - The scientific methodology for doing this exists

Climate Action Plan Advisory Group

Agriculture, Forestry, and Waste Technical Working Group Recommendations

Taken From:

Chapter 6 of the Draft Mitigation Options for Controlling Greenhouse Gas Emissions

For use at the 4 December 2007 Meeting of the Legislative Commission on Global Climate Change

Chapter 6
Agriculture, Forestry, and Waste Management

Overview of GHG Emissions

The agriculture, forestry, and waste management (AFW) sectors are directly responsible for a small amount of North Carolina's current greenhouse gas (GHG) emissions. For agriculture, net emissions were 11.0 million metric tons (MMt) of carbon dioxide equivalent (CO_2e) in 2000. Agricultural emissions include methane (CH_4) and nitrous oxide (N_2O) emissions from enteric fermentation, manure management, agriculture soils, and agriculture residue burning. As shown in Figure 6-1, emissions from agricultural soils and manure management in cattle account for the largest portions of agricultural emissions. The agricultural soils category includes N_2O emissions resulting from activities that increase nitrogen in the soil, including fertilizer (synthetic, organic, and livestock) application and production of nitrogen-fixing crops. Agricultural residue burning emissions are too small to show up in Figure 6-1.

Note that, in keeping with EPA methods and international reporting conventions, the inventory and forecast covers anthropogenic sources of GHGs. There could be some natural sources of GHGs that are not represented in the inventory and forecast; however these are not addressed in the CAPAG process. In the forestry sector, all emissions are treated as anthropogenic; since all of the State's forests are managed in some way (GHG reporting conventions are to treat all managed forests as anthropogenic sources). Sources such as carbon dioxide from forest fires and decomposing biomass are captured within the inventory and forecast (as part of the carbon stock modeling performed by the US Forest Service). However, methane emissions from anaerobic decomposition of biomass in forests are not currently captured due to a lack of data.

The contributions from agricultural soils and manure management have grown significantly since 1990, and they are projected to contribute 90% of agricultural emissions by 2020. Emissions from enteric fermentation have stayed the same since 1990 and are projected to stay relatively constant until 2020. GHG emissions from agricultural burning are estimated to continue to contribute a very small amount to the agricultural sector emissions.

Forestland emissions refer to the net carbon dioxide (CO_2) flux[1] from forested lands in North Carolina, which account for about 56% of the state's land area. As shown in Table 6-1, US Forest Service (USFS) data suggest that North Carolina forests sequestered an average of 23.7 $MMtCO_2e$ per year from 1987 to 1997. The CO_2 is sequestered in forest carbon pools such as live trees, debris on the forest floor, and forest soils, as well as in harvested wood products (e.g., furniture and lumber) and the landfilling of forest products. The data show an accumulation of carbon in each of the forest carbon pools during this period.[2] These rates of sequestration are assumed to remain constant through 2020.

[1] "Flux" refers to both emissions of CO_2 to the atmosphere and removal (sinks) of CO_2 from the atmosphere.

[2] This is not to say that the dead carbon pools (e.g., standing dead, forest floor) are sequestering carbon directly from the atmosphere. These pools accumulate carbon from trees/biomass that transition from a live carbon pool to a dead carbon pool.

Figure 6-1. Historical and projected GHG emissions from the Agriculture Sector, North Carolina, 1990–2020

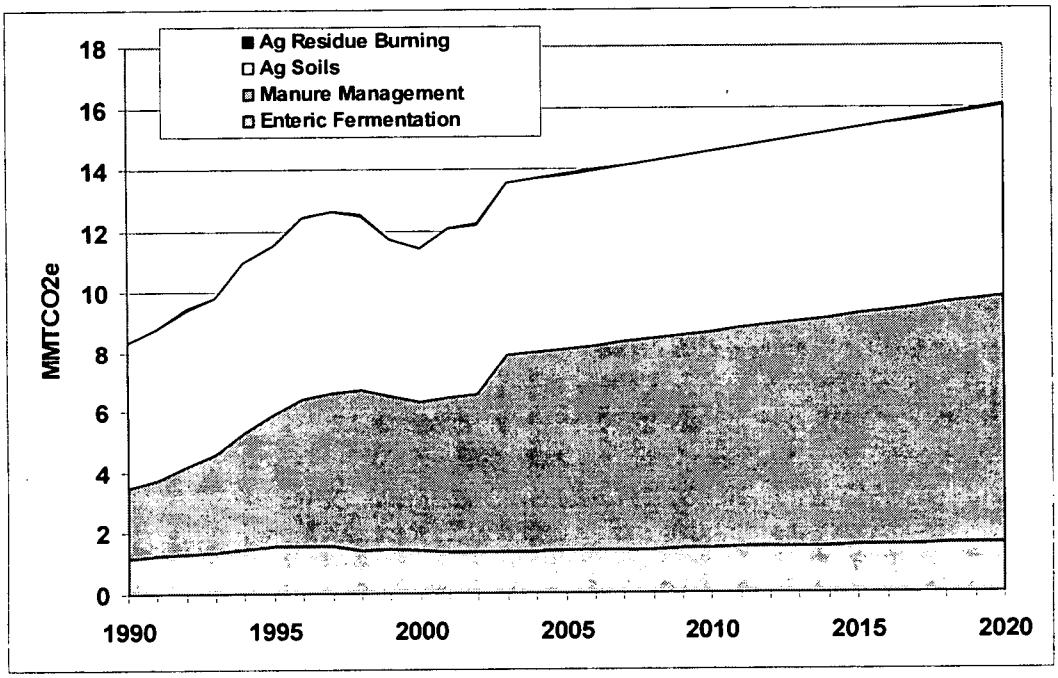


Table 6-1. GHG emissions (sinks) from the Forestry Sector

Forest Carbon Pool	1990–2020* $MMtCO_2e$
Live and dead-standing trees and understory	–6.9
Forest floor and coarse woody debris	–0.8
Soils	–3.1
Harvested wood products and landfills	–13
Total	**–23.7**

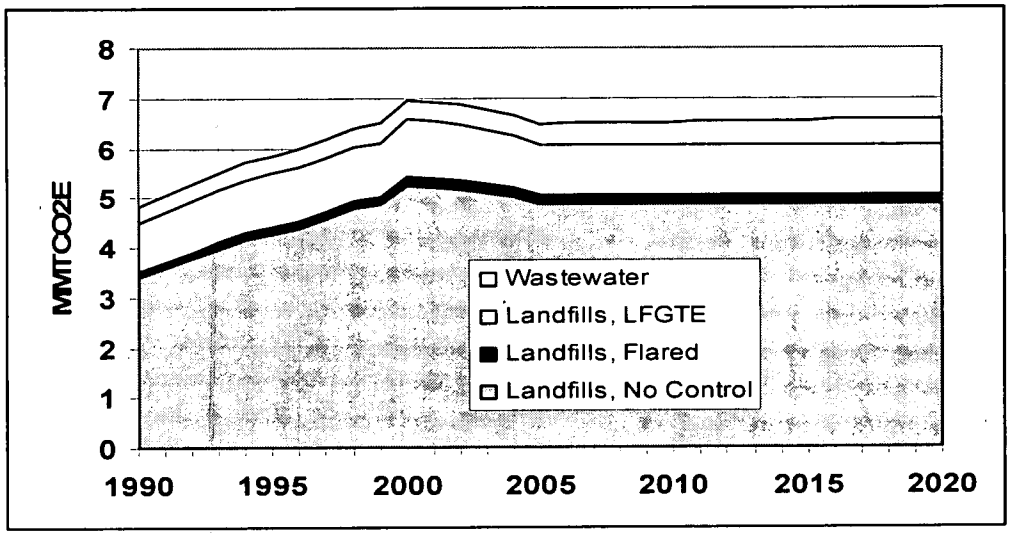
* Based on USFS data from 1983–1997.

Figure 6-2 shows estimated historical and projected emissions from the management and treatment of solid wastes and wastewater. Emissions from waste management consist largely of CH_4 emitted from landfills, while emissions from wastewater treatment include both CH_4 and N_2O. Landfill emissions are broken down into three subsectors: uncontrolled landfills (no CH_4 collection or control), flared landfills (CH_4 collected and flared), and landfill gas to energy (LFGTE) landfills (CH_4 collected and used as an energy source). Overall, the waste management sector accounts for less than 4% of North Carolina's total gross emissions per year from 1990 through 2020.

Opportunities for GHG mitigation in the AFW sector involve measures that can reduce emissions within the sector or reduce emissions in other sectors. For example, production of liquid biomass fuels can offset emissions in the transportation sector, while biomass energy can

reduce emissions in the energy supply (ES) or residential, commercial, and industrial (RCI) sectors. Similarly, actions that promote solid waste recycling can reduce emissions within the sector (future landfill CH_4), as well as emissions associated with the production of recycled products (recycled products often require less energy to produce than similar products from raw materials).

Figure 6-2. Estimated historical and projected emissions from waste and wastewater management in North Carolina



The following are primary opportunities for GHG mitigation.

- *Control and utilization of CH_4* —Methane emissions from manure management can be reduced through the use of anaerobic digesters or other technology. Methane can also be collected from landfills. The CH_4 captured can then be used to create electricity, steam, or heat to offset fossil fuel use.

- *Protection of forest and agricultural land from conversion to developed use*—By protecting these areas from development, the carbon in above-ground biomass and below-ground soil organic carbon can be maintained and additional emissions of CO_2e to the atmosphere can be avoided. Indirectly, these measures also support the objectives of "smart" development by helping to direct more efficient development patterns (see TLU-1a).

- *Beneficial use of forest and agricultural biomass*—Expanded use of biomass energy from residue removed from forested areas during treatments to reduce fire risk, crop residues, or purpose-grown crops can achieve GHG benefits by offsetting fossil fuel consumption (to produce either electricity or heat/steam).

- *Production of renewable fuels*—Production of renewable fuels, such as ethanol from crops, crop residue, forestry residue, or municipal solid waste, and biodiesel from crop

seed oils can produce significant reductions when they are used to offset consumption of fossil fuels (e.g., gasoline and diesel in the Transportation and Land Use (TLU) and RCI sectors). This is particularly true when these fuels are produced using processes and/or feedstocks that emit much lower GHG emissions than those from conventional sources.

- *Enhancement of forest carbon sinks*—Through programs that restore forests on lands that are currently not forested or under-stocked, additional CO_2 can be sequestered and stored in forest biomass. Similarly, in urban settings, expansion and maintenance of urban forests can increase sequestration and reduce energy consumption in buildings through shading and wind protection.

- *Retention of agricultural soil carbon*— Implement programs that incentivize growers to utilize cultivation practices that build soil carbon. By building soil carbon, CO_2 is sequestered from the atmosphere. Some cultivation practices also require the use of lower amounts of fossil fuels which further lowers GHG emissions.

- *Expansion of recycling infrastructure*—Increase the quantity of materials recovered for recycling with specific attention given to materials with the greatest ability to reduce energy consumption during the manufacturing process and to materials that may be used as a fuel source.

Key Challenges and Opportunities

In the agricultural sector, options to promote biodiesel and ethanol production were found to offer substantial GHG reduction potential with an estimated reduction of 7.7 $MMtCO_2e$ by 2020 (combined benefit of Options AFW-2 and AFW-6). This is the benefit from in-state production using North Carolina grown feedstocks and/or lower GHG production methods. The benefit is incremental to the benefit achieved via the renewable fuels standards incorporated in TLU-6. The benefits for both biodiesel and ethanol are based on production methods and feedstocks that have lower GHG emissions than conventional processes. For ethanol, this means processes that achieve much better GHG reductions than the production from conventional starch-based ethanol (the benefits of using ethanol from starch-based production are already accounted for under TLU-6). These processes could include cellulosic hydrolysis, biomass gasification combined with biofuels production, or alternative starch-based production methods (fermentation processes fueled by renewable fuels). Feedstocks for the fiber needed by this mitigation option could come from crop residue, forestry biomass, animal waste, and municipal solid waste. A major challenge for the success of AFW-6 is the production of a viable commercial-scale cellulosic ethanol industry by 2015.

For biodiesel, crop production should be promoted that results in significantly better vegetable oil yields than soybean oil, which is currently the most prominent feedstock in the United States. Candidates include vegetable oil crops like canola, sunflower, or jatropha that have much higher yields or emerging technologies like algal oil production.

The challenges for biofuels in North Carolina will be to identify and promote appropriate feedstocks for the production of these fuels. Limited analysis by the Climate Action Plan

Advisory Group (CAPAG) suggests that sufficient feedstock for cellulosic ethanol is available to meet the mitigation option's objectives. There is limited capacity within the state for crop production to support all of the biodiesel production envisioned by the CAPAG's recommendation without the use of cropland that is currently used for other purposes. Hence, careful study is needed to identify available croplands and appropriate crops for vegetable oil production. Funding and/or incentives will be needed to support the development of alternative biofuels production capacity, including research and development on emerging feedstocks and scale-up of production facilities.

As shown in the mitigation option descriptions in Appendix H, the implementation mechanisms developed for the agricultural sector should focus on methods that avoid conflict with potential future market-based GHG reduction programs. These include GHG credits that could be generated in the agricultural sector through renewable fuels projects, soil carbon projects, and possibly other project types. New regulations that mandate emission reductions or specific agricultural practices could limit North Carolina agriculture from taking part in emerging carbon markets. Implementation mechanisms that are incentive and education based can avoid these conflicts.

Combining the agricultural and forestry land preservation options (AFW-4a and AFW-4b), 4.6 $MMtCO_2e$/year in GHG emissions is estimated to be saved in 2020. To achieve these reductions, the state will need to work closely with local planning agencies, land owners, and nongovernmental organizations to identify lands suitable for acquisition/conservation easements and funding mechanisms. Another benefit to these options, which was not quantified, is the reduction in vehicle-miles traveled due to more efficient development patterns (see TLU-1a).

Within the forestry sector, afforestation of non-forested lands (AFW-8) has the potential to deliver an additional 2.4 $MMtCO_2e$/year in 2020. The mitigation option aims at afforestation of lands that are primarily agricultural today. Hence, a key uncertainty in the implementation of this option is whether or not landowners will be willing to accept a new form of land management that has a different investment structure than agriculture (e.g., different than the Conservation Reserve Program under the US Farm Bill).

Expanded Use of Forest Biomass and Better Forest Management (AFW-9&10) are estimated to deliver 5.9 $MMtCO_2e$/year in GHG emissions savings in 2020. The emission savings are offered through additional carbon sequestration in forest ecosystems and durable wood products and through fossil fuel offsets from forest-based energy (GHG benefits of fossil fuel offsets are accounted for in AFW-6 and in the RCI and ES sectors). Success will be achieved through close cooperation between North Carolina, federal agencies (USFS), and private industry to identify biomass resources and effective end uses for the resources.

Also in the forestry sector, AFW-13 (Urban Forestry Measures) has significant potential for GHG benefits (4.3 $MMtCO_2e$/year by 2020). This is a combination of direct benefits (CO_2 sequestration in urban trees) and indirect benefits (lower energy consumption in buildings through shading and wind protection) with the indirect benefits yielding most of the benefit. The biggest challenge confronting the success of this mitigation option is in containing the costs associated with tree planting and maintenance programs. For example, the costs of tree planting

programs can vary substantially depending on whether the labor is paid or unpaid. Hence, strong relationships between all of the related parties are needed (State Department of Forestry, utilities, communities, nongovernment organizations). Also, the ability to implement these programs in smaller and newer communities on previously cleared land may be limited by the administrative capacity of these communities.

Landfill Methane and Biogas Energy Programs (AFW-11) offers the potential for emission savings directly by controlling landfill CH_4 emissions and indirectly through offsetting fossil fuel use (2.9 $MMtCO_2e$/year by 2020). Challenges of this mitigation option include the location of landfills in very rural areas resulting in a lack of viable local end users, and the possible treatment as a regulated utility can also prevent landfill gas-to-energy projects from being developed. An additional benefit of this option includes reducing landfill gas emissions of volatile organic compounds, including some that are hazardous air pollutants.

Through implementation of AFW-12, additional GHG reductions can be achieved by increasing waste recycling programs in the State (0.5 $MMtCO_2e$/year). As with the landfill CH_4 option above, emission reductions are very cost-effective ($1/$MtCO_2e$ estimated for each of these options. Through recycling, emissions are reduced through avoided future landfill CH_4 and through lower energy consumption used in the production of recycled products versus products made from raw materials.

Overview of Mitigation Option Recommendations and Estimated Impacts

The CAPAG recommends a set of 12 mitigation options for the AFW sector that offer the potential for major emissions savings. As summarized in Table 6-2, the AFW mitigation option recommendations could lead to emissions reductions from reference case projections of 29 $MMtCO_2e$/year by 2020, cumulative reductions of around 213 $MMtCO_2e$ from 2007 through 2020, and a net cost of approximately $227 million through the year 2020 on a net present value (NPV) basis.[3] The weighted average cost of saved carbon is estimated at $1/$MtCO_2e$. The CAPAG believes that this represents an extremely low cost to the North Carolina economy in implementing this package of options.

The CAPAG mitigation option recommendations described briefly here (and in more detail in Appendix H) result not only in significant emissions savings, but offer a host of additional benefits as well. These benefits include, but are by no means limited to 1) support of North Carolina agricultural producers in the production of biofuels crops, development of new markets for agricultural byproducts, and training/outreach covering energy production, organic farming, and other areas; 2) creation of jobs in the biomass energy and liquid biofuels feedstock/production industries; 3) healthier forests with lower fire risk through the development of markets for forestry residue; and 4) research and development work to be conducted by North Carolina universities and other in-state organizations to support many of the options for this sector.

[3] The net cost savings are based on fuel expenditures, operations, maintenance, and administrative costs, and amortized, incremental equipment costs. All NPV analyses here use a 5% real discount rate.

Table 6-2. CAPAG Recommended Mitigation Options and Results for the Agriculture, Forestry, and Waste Management Sector

	Mitigation Option Name	GHG Reductions ($MMtCO_2e$)			Net Present Value 2007–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of Support*
		2010	2020	Total 2007-2020			
AFW-1	Manure Digesters & Energy Utilization	0.2	0.9	6.4	199	31	UC
AFW-2	Biodiesel Production (incentives for feedstocks and production plants)	0.2	0.8	5.1	286	56	UC
AFW-3	Soil Carbon Management (including organic production methods incentives)	0.2	0.2	3.0	–16	–5	UC
AFW-4a	Preservation of Working Land – Agricultural Land	0.2	0.3	2.6	290	114	UC
AFW-4b	Preservation of Working Land – Forest Land (formerly AFW-7)	1.7	4.3	36	112	3	UC
AFW-5	Agricultural Biomass Feedstocks for Electricity or Steam Production	0.009	0.02	0.2	10	54	UC
AFW-6	Policies to Promote Ethanol Production	0.9	6.9	38	200	5	UC
AFW-7	*Moved to AFW 4a*						
AFW-8	Afforestation and/or Restoration of Non-forested Lands	0.2	2.4	15	128	9	UC
AFW-9&10	Expanded Use of Forest Biomass and Better Forest Management	1.5	5.9	48	–639	–13	UC
AFW-11	Landfill Methane and Biogas Energy Programs	1.1	2.9	20	23	1	UC
AFW-12	Increased Recycling Infrastructure and Collection	0.2	0.5	4.1	4	1	UC
AFW-13	Urban Forestry Measures	1.4	4.3	34	–376	–11	UC
	SECTOR TOTAL AFTER ADJUSTING FOR OVERLAPS	7.8	29	212	222	1	
	REDUCTIONS FROM RECENT ACTIONS (none)	0	0	0	0	0	
	SECTOR TOTAL PLUS RECENT ACTIONS	7.8	29	212	222	1	

* UC = Unanimous Consent (all agree).

Agriculture, Forestry, and Waste Management Sector Mitigation Option Descriptions

The Agriculture, Forestry, and Waste Management Sectors include emissions and mitigation opportunities related to the use of biomass energy, protection and enhancement of forest and

agricultural carbon sinks, control of agricultural CH_4 emissions, production of renewable fuels, use of methods to increase soil carbon, achievement of afforestation on non-forested lands, and an increase in recycling.

AFW-1. Manure Digesters and Energy Utilization

The CH_4 emissions inherent from the anaerobic decomposition process of manure and other wastes may be captured and used as an energy source. By doing this, it is possible to both reduce CH_4 emissions and offset fossil-based energy. However, the cost of emission capture and energy production can be higher than the value of the energy collected, making this option cost prohibitive for producers operating in a tight-margin business. This option covers programs to increase the number of CH_4 capture and energy recovery projects using manure or other wastes (including food processor waste). The goal is to capture 20% of available CH_4 from confined animal operations by 2020 for use in energy projects. The mitigation option is designed to apply to hog farms and dairies in the state.

AFW-2. Biodiesel Production (Incentives for Feedstocks and Production Plants)

Use of biodiesel offsets the consumption of diesel fuel produced from oil (fossil diesel). Since biodiesel has a lower GHG content than fossil diesel, overall GHG emissions are reduced. By producing biodiesel in the state for consumption within the state, the highest benefits can be achieved, since the fuel is transported over shorter distances to the end user. This option covers incentives needed to increase biodiesel production to offset 12.5% of North Carolina's fossil diesel consumption by 2020.

Note: This option is linked with Transportation and Land Use Option 6 (TLU-6) on Biofuels. This option seeks to achieve incremental GHG benefits beyond the TLU option by promoting in-state production of biodiesel using feedstocks with greater GHG benefits than the likely business-as-usual national production methods. In addition, North Carolina consumption of biodiesel produced in-state will produce better GHG benefits than biodiesel obtained from a national market because of the lower embedded CO_2 associated with transportation of biodiesel or its feedstocks from distant sources.

AFW-3. Soil Carbon Management

Use of conservation tillage, no-till methods, cover cropping, and other soil management practices can increase the level of organic carbon in the soil, which sequesters CO_2. In addition, some practices lower fossil fuel consumption through less intensive equipment use. Other practices, such as the application of bio-char, can also increase the level of soil carbon and improve the soil.

Another element of this option is the promotion of certified organic production techniques. A number of studies have found that organic production of row crops results in GHG benefits, including higher levels of soil organic carbon relative to those from conventional production methods. This option is designed to increase the acreage using soil management and production

practices that lead to higher soil carbon content and other GHG benefits. Specific goals include applying soil management practices on 20% of acres that currently do not use these practices by 2010 and increasing that amount to 50% by 2020.

AFW-4a. Preservation of Working Lands – Agricultural Land

This mitigation option seeks to reduce the rate at which existing crop and pasture are converted to developed uses. The carbon sequestered in soils and aboveground biomass is much higher in croplands than in developed lands. Policies are needed to preserve working farms and forests (see AFW-4b) from unwise and unplanned development. This option should be seen as a companion measure to TLU-1a (Land Development Planning).

State and national programs have been established to protect farm communities from conversion to development. Funding state farmland preservation programs will help meet goals and act as a needed match to national programs. Programs that help farmers transition lands to beginning farmers are being investigated. The goal is to reduce the rate at which agricultural lands are converted to developed use by 50% by 2020 from current levels.

AFW-4b. Preservation of Working Lands – Forest Land

North Carolina has lost, on average, 61,390 acres of productive forest each year over the last 30 years to development and a lack of post-harvest regeneration. This amounts to a loss of about 10% of the state's forestland since 1974, or an annually compounded loss of about 0.36%. The goal of this option is to reduce the rate of conversion of forest lands to non-forest lands by 10% by 2010 and 25% by 2020. When converted to developed areas, these areas contain lower amounts of biomass and its associated carbon. These areas also sequester less CO_2 than forested areas. When landowners don't have the incentive to retain their ownership, they often not only sell for development, but they may also sell a forested tract as smaller parcels which may then be too small to allow forest management to be practical. On tracts too small and fragmented to be managed, the goals of AFW 9&10 cannot be achieved.

AFW-5. Agricultural Biomass Feedstocks for Electricity or Steam Production

This mitigation option seeks to offset fossil fuel use with agricultural biomass as feedstock for electricity, steam, or heat generation. Agricultural biomass includes, but is not limited to, poultry litter, livestock manure, and crop residues, as well as energy crops (e.g., switchgrass and hybrid poplar). Offsetting fossil fuel use reduces the GHG emissions associated with these fuels. The goals are to increase agricultural biomass usage to utilize 10% of available biomass by 2010, 25% of available biomass by 2020, and 50% of available biomass by 2030. Voluntary, incentive-based programs should be used to foster development of the industry and associated economic markets.

Note: This option links with AFW-1, which promotes the use of anaerobic digesters and energy utilization. It explores additional opportunities for agricultural biomass energy use. This option also has linkages to ES-1 (Renewable Energy Incentives), ES-2 (Environmental Portfolio

Standard), ES-10 (NC GreenPower Renewable Resources Program), and RCI-10 (Distributed Renewable and Clean Fossil Fuel Power Generation).

AFW-6. Policies to Promote Ethanol Production

Offset fossil fuel use (gasoline) with production and use of starch-based and cellulosic ethanol. Offsetting gasoline use with ethanol can reduce GHGs to the extent that the ethanol is produced with lower GHG content. Provide incentives for the production of ethanol from crops, forest sources, animal waste, and municipal solid waste. Several projects are being proposed that would result in the production of 150 million gallons of ethanol annually in North Carolina by 2008. Incentives could increase this amount to a volume equivalent to offsetting gasoline consumption in the state by 10% in 2015 and 25% by 2025. These goals are based on cellulosic ethanol being commercially viable by 2015.

Note: This option is linked to TLU-6, biofuels option, which focuses on mechanisms to increase biofuels consumption in North Carolina. The quantification of benefits and costs for each option takes into account the anticipated GHG reductions to be achieved by each.

AFW-8. Afforestation and/or Restoration of Non-Forested Lands

Afforestation, the planting of trees on lands that have not recently supported forests, has both carbon sequestration and other environmental benefits—storing more than one ton of carbon per acre each year (on-site, not including off-site storage and offsets in products). Afforestation delivers other important benefits such as improved wildlife habitat, reduced soil erosion and fertilizer runoff, and new recreational opportunities. Existing afforestation programs are underfunded for the task of this afforestation; typically, there is a long waiting list for landowner forestation projects. This option covers the provision of additional incentives to increase the rate of afforestation and restoration (e.g., increased stocking on poorly managed stands). The goals are to achieve afforestation projects on 40,000 acres of land by 2010 and a total of 540,000 acres by 2020.

AFW-9&10. Expanded Use of Forest Biomass and Better Forest Management

This mitigation option seeks to expand the production and use of wood products for solid wood products, fiber, and fuel. Such use offsets fossil fuel burning in the production of substitute materials (e.g., cement or steel for solid wood products and plastic for wood fiber). Wood can substituted for fossil fuels directly in the case of biomass for energy. However, these GHG benefits are not explicitly included in the analysis, which focuses on direct carbon sequestration in forests and in wood products. Having a market for relatively low-value biomass products enables forest management for higher value solid wood products. The increase in growth and yield of production from sustainably managed forest resources can be done through site preparation, competition control, thinning, fertilization, and improved genetics. The goal is to increase forest productivity by 100% on half of North Carolina timberlands by 2020.

AFW-11. Landfill Methane and Biogas Energy Programs

Provide incentives that will result in an increase in the recovery of landfill CH_4 for use as an energy source. Increasing recovery of landfill CH_4, reduces emissions of GHG and offsets the use of fossil fuels for commercial and industrial heat/steam generation or electricity production. Of approximately 130 open and closed landfills in the state, only about 15 sites are currently recovering landfill CH_4 for energy use. The aim of this mitigation option is to increase the number of uncontrolled municipal solid waste landfills recovering CH_4 as an energy source, such that 50% of the landfill gas being generated is controlled by 2020. This can be done through the development of additional LFGTE projects. For sites where LFGTE is not feasible, the aim is to implement flaring controls.

Note: This option has linkages to ES-1 (Renewable Energy Incentives), ES-2 (Environmental Portfolio Standard), ES-10 (NC GreenPower Renewable Resources Program), and RCI-10 (Distributed Renewable and Clean Fossil Fuel Power Generation).

AFW-12. Increased Recycling Infrastructure and Collection

Increase the quantity of materials recovered for recycling with specific attention given to materials with the greatest ability to reduce energy consumption during the manufacturing process and to materials that may be used as a fuel source (e.g., clean wood waste). Reducing the quantity of materials being put in landfills reduces the potential for future landfill CH_4 emissions, while recycling reduces emissions associated with the manufacturing of products from raw materials. The aim of this mitigation option is to increase per capita recovery in the state by 25% by 2020.

AFW-13. Urban Forestry Measures

Urban forest cover protection and management offers a potentially cost-effective mechanism to reduce energy use, to store/sequester carbon, and to mitigate land use change (conversion of forest and agricultural lands to residential sites). Strategic planting of trees to shade houses and AC units can yield energy savings of 15% to 50% on cooling costs. Planting shade trees can reduce summer heating costs, with only marginal increases in winter heating costs, particularly in mild climates. In addition, depending on local conditions, tree planting can reduce wind speed and further reduce energy costs. The net direct impacts of tree planting are estimated to be positive, taking these factors into account.

Specifically, this mitigation option aims to increase urban tree cover by planting three additional trees (i.e., three more than planned) on all new construction sites starting in 2008 and by planting three new trees on 25% of existing housing units in 2007 by 2020, with the aim of achieving a 25% reduction in annual heating and cooling costs.

Global Climate Change Commission Meeting
Wednesday, January 16, 2008
10:00 a.m.
Room 643 LOB

The Legislative Commission on Global Climate Change met on Wednesday, January 16th in Room 643 of the Legislative Office Building with Representative Pricey Harrison, Co-Chair, Mr. Garrou, presiding. Other members present were: Sen. Albertson, Sen. Cowell, Sen. Pittenger, Rep. Allen, Rep. Underhill, Rep. Wilkins, Mr. Clark, Dr. Eggers, Mr. Tim Toben, Mr. Urlaub, Mr. Robert Glaser, Ms. Tompkins, Ms. Choi, Mr. Everett, Mr. Howard, Mr. Nelson, Mr. Peele, Mr. Profeta, Dr. Riggs, Ms. Preyer, Mr. Slocum, Dr. Smith, Mr. Stephenson, and Mr. Ebert.

Mr. Garrou called the meeting to order to order and asked Mr. Givens for remarks or explanation of the agenda items.

Mr. Givens: Thank you Mr. Chairman I have a number of things to discuss with you this morning. First of all I encourage all the members to sign the reimbursement forms and send them up to the clerks. For the visitors in the back, I encourage and ask you to sign the visitor's registration sheet (**Exhibit A**) which is on a clip board back there somewhere. With regards to some things that you need to know regarding the February meeting which will be held in connection with the Emerging Issues Forum and the focus of that forum is on energy and that will be February 11th and 12th. You have at your place an invitation (**Exhibit B**) from the Forum as well as a one page sheet to tell you how to register. If you are a member of the Legislature, your registration fee is comped by the form. If you are not a member of the legislature, then you will need to pay the registration fee for government officials and that will be reimbursable with a receipt in connection with your request for reimbursement for attendance of the February meeting. I don't want to pay for registration fees for people who don't want to attend. So I encourage you to be thoughtful about it, this is the February meeting and so I hope you will be able to attend both days, registration fee for government officials is $200 and again that is reimbursable. My concern is that the form registration will close when they receive their maximum projected attendance for enrollment. They indicate that will occur this week. You can register online, now I make this invitation in particular to members of the Commission because it is our February meeting but this forum is open to any one in the public and if you're back there in the back and would like a copy of the invitation we have plenty to hand out to you. Now there will be a business meeting of this Commission in connection with the forum. That is the only part of the forum that you don't have to register or pay a fee to attend. If the only thing you are going to do is come to the meeting of the Commission, you do not have to register. Because it is a public meeting it will be accessible to folks who don't have the badge to attend any of the forum events. That business meeting will be held from 2:30 – 3:45 in Room 2 at the McKimmon Center. The purpose of that meeting is to hear from the chairman of the International Panel

on Climate Change, Dr. Pachauri. This is I think a major accomplishment for this Commission. Dr. Pachauri is a Nobel Laureate this year for his work on climate change and the way this is going to work is this: there is an agenda item on the agenda today, agenda item 6 which will be Commissioner Eggers who will outline for us the most recent report from the International Panel on Climate Change. That is by way of preparation for the February meeting and we are doing it this way for this reason. We will have our meeting and we will have Dr. Pachauri with us before he addresses the forum, he actually addresses the forum at 4:00. Ideally he would address the forum and then we would have our meeting and we could have a question and answer session but we could not schedule that. So the thought process here is that today you will get an introduction to the most recent report of the IPCC. I hope that at any point doing that discussion or any point after this meeting if you had any thoughts about questions that you would like Dr. Pachauri to address or issues you would like for him to explore in particular when he meets with us, if you will let me know, I will communicate that to him. I am not communicating with him directly but with three first persons, but the invitation is out there. We want to make the best possible use of the hour that we have with him. So we are going to prepare for that today. Please plan on attending that whether or not you plan to attend any other part of the forum. If you don't plan to attend any other part of the forum you do not have to register and you do not have to pay the registration fee. If you wish to attend any part of the forum, you do need to register and that is either comped or reimbursable, there is a little wrinkle on the comped for a couple of people I'll be around to see you individually. There is a dinner Monday night for invited guest to the forum and all of you who are members of this Commission fall into that category. They are supposed to send me a letter which I will forward to you if you are going to attend the forum you should plan on joining us for dinner Monday evening. I will do my best to answer any additional questions. We have a handout for you which comes from NC State Alumni magazine (**Exhibit C**) and in it a brief article about Dr. Pachauri, his picture is on the cover and it's a question and answer interview type format.

It will be necessary for various logistical reasons to reschedule the April meeting. I am hopeful that we will have a proposed date later in this meeting. We are doing some checking right now, once the co-chairs and counsel have agreed upon an option of dates we are basically looking at the week following the week we have scheduled. We will try to put that out there and I would be interested to know if there are conflicts. You can be checking your calendars and thinking about that. We are going to try to settle among ourselves up here on the week of April 21st. I regret it is necessary to reschedule but it is.

There will be various handouts during the day I know Sen. Pittenger has something he wants distributed and he will undoubtedly hand it up here to us so we read it into record and distribute to you later. There is a document that is his with the words draft (**Exhibit D**) that should have been distributed to you. It is a legislative proposal to prepare North Carolina's agricultural and forestry sectors for emerging carbon market place, this comes from the Environmental Defense

and the Nicholas Institute. Now here is our basic plan as things now stand. We have today's meeting and I think the agenda (**Exhibit E**) is fairly self-explanatory. We are going to talk about mitigation strategies. For some of you the term mitigation may be confusing and mitigation sounds like adaptation, it is my understanding and there are others of you that know more about this than I do. We use the word mitigation when we mean ways to mitigate the impacts of carbon emissions or reduce carbon emissions so as to mitigate or reduce them. Adaptation refers to what we do in response to whatever global climate change is occurring. There have been a lot of interest and talk about adaptation so we have a good adaptation agenda item for you today.

The report from the Frontier Group which is associated with the public interest research group is very (inaudible) request of the co-chairs and then Dr. Eggers item as I indicated earlier. I've just described to you the February meeting. At the March meeting we intend to return to consider of proposals Mr. Peterson will give a very brief report on his efforts to streamline the presentation of those so that we can do that more efficiently. We will consider the proposals from Nicholas Institute and Environmental Defense and others that come our way. That will get us through March and then we will see about April and May. As things now appear, it seems very likely that we will continue this Commission for at least one more year to 2009, I've had some conversations with the leadership and as I've been saying all along, we didn't get into the climate change problem in a year or two and we will not get out of it in a year or two. There is some thought that we ought to develop a more permanent institution but the thought is that would best be done in 2009 for reasons that may be obvious to you. Those are the points that I think I need to cover. I may have more particulars on the date of the April meeting. I'll be happy to answer any questions.

Mr. Profeta: Thank you Mr. Chairman I just note that I don't see that document is distributed yet but we will make sure it gets to your desk before we're done here.

Mr. Givens: I thought it had been but I think I have the whole pile up here and we'll correct that right now.

Mr. Garrou: Dr. Riggs I am so glad you are here today when we're talking about adaptation. It would have been very disappointing if you had not been here.

Dr. Riggs: (Inaudible)

Mr. Givens: That appears on the back of your agenda under schedule of future meetings, it is Monday 11 February with the business meeting from 2:30 – 3:45 p.m. That is actually doing a breakout session of the forum. That will be in Room 2 of the McKimmon Center. While I'm talking I did have one other thing – some people do call in and let me know about their membership status. Mr. Cecich indicated he could not be here today and I appreciate knowing that. I want to introduce the Commission to Mr. Lewis Ebert who is president and CEO of the North Carolina Citizens for Business and Industry also known as the North

Carolina Chamber of Commerce. Mr. Ebert joins us in that capacity and also Douglas Crawford-Brown has indicated to the Commission that he will need to be replaced, actually I think he can replace himself since he holds this position ex-officio, for personal and family reasons he needs to reduce his demands on his schedule. So I have invited him to select his own replacement as provided by the session law.

Mr. Slocum: (Inaudible)

Mr. Givens: Yes sir for members of this Commission it is reimbursable as an expense because it is in effect an official activity an assignment if you will, for members of the Commission to attend if at all possible. No sir you should put it on the form for your February meeting. You will need to attach the receipt.

Mr. Tad Aburn: (**Exhibit F Slide presentation attached**)

Dr. Riggs. Thank you very much for the information. Most of your discussion dealt with greenhouse gas reduction emission reductions but over and over again you mentioned your aggressive approach and the risk of your coastal system. Could you give us some examples of what Maryland is doing with respect to the coastal portion and what does aggressiveness mean with respect to that.

Mr. Aburn:

Representative Allen: Thank you Mr. Chair and thank you so much Mr. Aburn. What did you say the percent of coal being used in Maryland was? Was it seven or seventy percent?

Mr. Aburn:

Mr. Glaser: Thank you Mr. Chairman. Mr. Aburn thank you for coming down with us. Mr. Aburn you referred a couple of times to the science behind an 80-90 percent reduction by the year 2050 and a difficulty in measuring what specific goals you recognized at the end. Where is that science coming from? Is that agreed upon science or is that what your commission sort of settled on as a target goal. That's the first question, the second question is do you have examples of any information relative to the cost of implementing, what type of cost is burdened by the consumer, what type of cost is burdened by the government, what type of cost is burdened by the federal government? Thank you.

Mr. Aburn:

Mr. Glaser: Mr. Chairman, if I may follow up? If I could, what I was looking for is what type of cost, you know when you talk about putting a goal in place by the year 2015 or 2012; some body is going to have to pay that cost. I know with automobiles and transportation there is an increased cost. But I assume there

has been some discussion in the state of Maryland in the Maryland Legislature about this and what I was looking for is what examples did the legislature discuss as far as the exact cost on the consumer?

Mr. Aburn:

Representative Wilkins: Thank you Mr. Chair. Mr. Aburn I would be interested in knowing the total number of employees in the Maryland Department of Environment and I would be interested in knowing if your commission has had any discussion about what the effect on that number might be?

Mr. Aburn:

Representative Wilkins: I would be interested in that information and I believe other folks in this room might be as well. Thank you.

Dr. Smith: Thank you Mr. Chair. Appreciate your presentation, two things one building off this cost question and this may be more appropriate for adaptation follow up, have you tried to quantify the impacts to Maryland in the form of sea level rise, salt water intrusion into fresh water drinking supplies, other potential impacts from storm surge. How much has the state really gone to the effort to have an ability to know what this ultimately is going to cost because when we're looking at the cost equation there is not only the direct cost of implementing these programs but the cost of inaction can be many, many times that and moving forward. So I am just curious about how much do you feel like you have a solid figure or how much effort has there been in trying to quantify the impact?

Mr. Aburn:

Dr. Smith: And I was intrigued about how you all have approached the goal question because that is an issue we are struggling with and clearly having the science drive and aspirational goal and be sort of one, and I may have missed this in your presentation, but have you all tried to assemble the policies that appear to be for lack of a better term, sort of low hanging fruit or and see which projectory that puts you on and then try to identify the gap or the delta between and a here we are now, here is where the science is saying and I know you were going to sort of four year checking I think. But how much are you attempting to look at sort of the implemental realistic policies that are sort of on the books or on the way versus the scientific goals in trying to understand the delta there and tweak them to the numbers accordingly. How does that work out in your process?

Mr. Aburn:

Dr. Smith: The 2020 goal does appear, you think, to be somewhat and that's added as sort of things on the books and on the way.

Mr. Aburn:

Senator Pittenger: Thank you Mr. Garrou. Mr. Aburn thank you for being here, Mr. Aburn do you have a formal relationship with CCS.

Mr. Aburn:

Senator Pittenger: Ok are you part of those as well?

Mr. Aburn:

Senator Pittenger: Are you a consultant to them as well?

Mr. Aburn:

Senator Pittenger: You mention a number of proposals that you all were initiating that would pay for themselves in the long run. Has there been a cost benefit analyses for those proposals?

Mr. Aburn:

Senator Pittenger: So it is yet to be determined how they will pay for themselves in the long run?

Mr. Aburn:

Senator Pittenger: The Bakom Hill Reporter, have you read that?

Mr. Aburn:

Senator Pittenger: It had some questions in terms of methodology of some of these cost benefit analyses and I was just curious what you might know about it.

Mr. Aburn:

Senator Pittenger: Ok thank you.

Representative Harrison: Thank you Mr. Chair and thank you Mr. Aburn for making the trip. I just want to follow up on the clean cars piece of your strategy. I assumed you all adopted the California standard which is subject to litigation. I saw in here a reference to taxing energy and efficient vehicles and I want a little bit more detail what you all are doing about the vehicle emissions?

Mr. Aburn:

Mr. Givens: I think I heard you mention that Maryland is projected to have a shortage of electricity fairly soon. Is Maryland a regulated state at this point or deregulated state?

Mr. Aburn:

Mr. Givens: Ok, do you have a public utilities commission left that can address the shortages or how does Maryland propose to address the shortages?

Mr. Aburn:

Mr. Givens: I would appreciate that thank you.

Dr. Everett: Could I just ask one very simple question. It would be your 13th slide on page 7 of our handout, a sampling of state targets. I just don't understand what that table is. If you could just walk through any state across the page and explain Arizona, for instance.

Mr. Aburn:

Dr. Everett: So for the Maryland example you had projected apparently that between 1990 and 2020 you would grow by 50 percent is that the projection?

Mr. Aburn:

Dr. Everett: And then, of course, your goal is to not grow that you would be 25 percent below your 2020 goal so you would cut that in half maybe, is that correct?

Mr. Aburn:

Dr. Everett: So you would still increase, you don't increase by 25?

Mr. Aburn:

Dr. Everett: So the projection as you would have been up 50 percent, your goal is to be down 25?

Mr. Aburn:

Mr. Garrou: Thank you very much Mr. Aburn for coming and speaking to us. Mr. Givens has an announcement.

Mr. Givens: Senator Pittenger has sent forward two press (**Exhibit G**) releases that are contained in a folder the sergeants will distribute that and be made a part of the record. Let me repeat what I've said to you occasionally in the past. Members of the Commission and public to send material to the Commission and

to the staff and we are glad to have it. It does not however become a part of the record unless it is handed up during the course of the meeting and read in so that the clerk can record it as an attachment to the minutes. If you have something you want added to the record, please use that procedure. Thank you Mr. Chairman.

Mr. Garrou: Our next speaker is Kenneth Colburn who is the senior consultant for the Center for Climate Strategies and he is going to talk to us about adaptation in Maryland.

Mr. Colburn: It's a delight for us to be here today. I am with CCS and Bill Dougherty is with the Stockholm Environmental Institute and does a lot of work with CCS. Bill has international experience in adaptation efforts as well. So we are pleased to offer you some initial thoughts regarding adaptation to climate change. The first and foremost concept that is important to recognize is just what new ground adaptation is, not only for the states but indeed for the globe. There is a bit of political legacy to that unfortunately as well. As many of you know, for long periods of time climate change has been viewed as mitigation or adaptation. We are going to work to solve this problem or we are going to just adjust to it. That almost became an article of faith you know, were you of the mitigation state or were you of the adaptation faith. And adaptation was viewed as the capitulation to efforts to try to solve the problem. Now that we've delayed concrete action on climate change long enough that its impacts are beginning to be visible, it is much more clear that we need to do both which is where we should have been all along in the first place. Those of you on the Commission who are readers of Governing Magazine probably saw the recent piece they did on local warming and that also brings home an important point and that is that all adaptation will be local and all the impacts of climate change will be local for states and municipalities. So states have indeed started to act and to get their arms around what adaptation means for their state, what kinds of impacts will they have to respond to and at CCS we have found that the approach was used whereby we gather stakeholders from the state, they identify a number of options, select from those options which are priorities and then dive deep into those priority options. It appears to be a workable model as well. None of those is complete at this point. Maryland is the first one out of the gate, Washington has done a little work, basically Bill will describe for you what is driving adaptation, what characterizes it and how it appears to be best approached and then I will follow up with a little bit of what's been done in some of the states who have started processes. But I'll just leave you with this is all very, very new even in the state venue and indeed globally. Thank you.

Mr. Bill Doughterty: Good morning everybody I think the first thing I would like to say is that it is a real pleasure for me to be here and talk to you a bit about adaptation to climate change. I was involved in the process in which this state here looked at mitigation of greenhouse gas emissions and so I think this topic here of how can the state begin to think about the process of adapting is not only timely but you might even consider it an urgent matter given what the scientists

are telling us about sea level rise and other aspects of the climate regime. I think what I would like to do just echoing what Ken mentioned is try to give you an overview of what I think are some of the key questions that would be worthwhile to consider as you think about tackling the problem of adaptation to climate change. I think some of these initial questions as I see them have to do with what is exactly the concern here in North Carolina? Are they concerns about the effects of climate change on coastal areas, or your water resources, are they related to the impact of climate change on public health issues, agricultural production and probably the list can go on relatively to your own particular concerns that you would bring to the table. Adding on to that is the key question of who exactly are the impacts going to hit? Who is affected by climate change? Are they the priority people, are you thinking about home owners, are they farmers, are they small businesses, large businesses and in terms of how you look at the problem it is important to think about actions that can be undertaken within the near term, say within the next five to ten years you should get the process of adaptation going and actions that would take place far into the future.

Another key question as I see it would be for what purpose is the process would you want to initiate a process of adaptation here in North Carolina to basically raise awareness among key constituents, general public, is it targeted toward major policy changes perhaps even some legislative decisions. What kind of outputs would be needed and this is, I think, a very key question. There was an earlier question by Dr. Smith about the outputs of the Maryland process and one of the key questions you might ask yourself here is the output of this effort, any potential effort in adaptation in North Carolina would be to better understand the impacts. That is to get a handle around the science, what the science is saying about what will be some of the physical impacts on the natural system here in North Carolina or are you looking for something else in terms of perhaps near term adaptation options or even long term policy decisions regarding adaptation to climate change.

And finally, you will also have to tackle with the real world issues of what kind of resources are available relative to the time that you have to tackle the problem, the capacity in terms of your institutional, technical universities, scientific capacity and all the funds available for such an effort. Rainfall runoff reduced crop yields are we talking about an increase demand for electricity to deal with higher summer heat. And finally adapted capacity focuses on what specifically exist in the state to adapt to climate change. Are the institutions prepared to deal with the issue, is the resource legislative based, is the infrastructure that's in place capable of adapting to this change in the climate. When we talk about vulnerability we are also talking about how each of these three enters play with one another. More exposure and sensitivity increases vulnerability while the more adaptive capacity they had that has defected decreased vulnerability for the impact. My sense is that any process that you are thinking about beginning here in North Carolina should really try to focus in all three of those dimensions. I've used the word probably 100 times by now, adaptation, but I never really have taken the time to define it and I hope it has generated a question in your mind,

what exactly am I talking about when I say adaptation. This slide here refers to the IPCC's definition of adaptation and if you will allow me to read it, it says that adaptation is an adjustment in natural and human systems in response to actual or expected climate stimuli or their effect which moderates harms or exploits beneficial opportunities. And that is from the 3rd assessment report.

There are two basic types of adaptation that we can talk about and the first is our economists what is called by analyst economist or reactive adaptation and it basically refers to what people tend to do, what systems tend to do as the impacts of a changing climate becomes apparent. They are reactive they are not planned they are simply what people feel is necessary to do to deal with reality that they are facing. Another is anticipatory or proactive adaptation. Here we are talking about a whole different set of measures that could be taken that focus on how to reduce the potential risk associated with what is known about climate change. And in so far as the process is being considered to take place in North Carolina it's probably a very good focus on the latter type that is anticipatory or proactive adaptation. Now adaptation is also a little different than the mitigation role in so far as the kinds of actions or measures that could be implemented are very different and they are all aimed at not reducing CO_2 emissions but rather at reducing the vulnerability of the communities in your state to the impact of climate change. And as Ken was mentioning, we've been working in Maryland on this issue and we've developed a catalog of potential adaptation actions that could be thought about in the broad sense but specifically for Maryland in the areas of coastal zones, human health and natural resources. And this universe of options is basically populated with about 200 or so actions and we took that as a basic starting point for thinking about how to whittle that down into specific relevant and pertinent actions of the state of Maryland to consider.

This is an extract from that adaptation catalogue, you will see in the left column option numbers 1.1 – 1.10, it actually goes down to page #30. And this is an adaptation extract focusing on the current built environment and infrastructure in Maryland and the second cost on the left focuses on the types of adaptation actions that could be taken. The next three columns focus on some of the evaluation criteria that the stakeholder consultations are focusing on in evaluating each of these options and then there is a place for (inaudible). In terms of a broad outline of the adaptation process in North Carolina the way I think CCS looks at it is that it probably represents the three step process. The first is initial fact finding, I have a very strong sense, although I am not familiar with the lay of the land here in North Carolina, that there is quite a bit of research on the impact of climate change that is going on at your universities and institutions and the first job would be to try to come up with a good sense of what kind of analyses has been done, how has vulnerability been defined, what are the risk, what are the key ecosystems or other systems that are at risk from climate change? The second key aspect would be state (inaudible) giving the opportunity for citizens in the state to come together and think through what makes most sense for North Carolina given your precious resources and the issues that confront you. And finally some sort of report that provides a set of

recommendations that could inform policy makers as they tackle the next big step of actually implementing some sort of program to deal with adaptation of climate change. I think that from what little I know that probably it's a safe bet in North Carolina to think about interest and adaptation focus on these four areas listed here in this slide, coastal zones, water resources, human health, and terrestrial ecosystems. I could be off their science I am not familiar with the work that has been done here, but my sense in the limited review of the literature of North Carolina is that these are probably the big ticket items in this state. With that I'll just turn it back over to Ken to give you some more specifics about what we are doing in Maryland.

Mr. Kenneth Colburn: Thank you Bill. Actually I will try to put that back up, it may be useful in just wrapping up this discussion, I will try to share a few thoughts about how Maryland and some other states have organized their thinking going in. None of these processes have ended yet so we can't provide you with the conclusions of them regrettably. But there are some insights that are emerging. What Maryland did in terms of its coastal zone protection was actually split into two technical work groups associated with coastal zones. One it called its existing built environment and infrastructure and a second being the future built environment and infrastructure. The basic thinking there being we have a whole lot of capital stock in the ground – what are we going to do with it. Some need to be protected, some need to be abandoned or is likely to be abandoned, how should we make the judgments about which is which, how do we deal with the conflicting interest about which is which and so forth. At this stage Maryland like most states is just trying to get its arms around what are the issues and parameters in metrics involved and even contemplating these kinds of decisions. A good example is they have a regulatory regime associated with 1000 ft. barrier from high tide levels. That was taken and instituted in legislation in 1972 and there is a whole different area now covered with the advent of sea level rise and the land subsiding that's occurred in Maryland. So the 1000 ft. buffer is no longer, it is more like a four or five hundred foot buffer. So that has to all be redone – so they are trying to get their arms around these kinds of issues. In terms of the future built environment, of course, the tap there is reasonably obvious. It is how do we avoid getting in a similar situation with our future construction and one of the things that's really emerged as the unified field period in Maryland is the perception that the state doesn't want to get in the business of being the insurer of last resort. You've already experienced some in property and casualty insurance companies deciding to take a pass on issuing coverage in the coastal states probably some here even in North Carolina. In some cases, I think Florida is taking a step in this direction, the state has stepped in to say ok we will cover, keep writing, we'll be your re-insurers. The trouble is when you get a major storm like which we've seen a few recently and there are substantial losses, billions of dollars of losses you're effectively saying that the state tax payers will be the re-insurance mechanism. Now if you do that (inaudible) built, the storm destroys the infrastructure rebuild it at cost, now there is a bigger storm because we haven't adapted a plan for adaptation. You rebuild it again each

time the state being insurer of last resort. Albert Einstein offered that madness is doing the same thing over again and expecting a different result.

If Maryland hasn't nailed down exactly what it is going to do in the adaptation front or at least understands Einstein's position and doesn't want to follow. Maryland also has chosen as Bill indicated here a work group investing human health, safety and public welfare and that includes everything from how to deal with diseases that are likely to occur, we will see more (inaudible) fever and more West Nile kind of thing. What sort of monitoring systems, tracking systems, early warning systems should there be on that front. Right on through public welfare being emergency warning systems, storm events have evacuation plans to help them there. What Maryland has found interestingly enough is one example, is that we normally think of storm surges as representing the biggest threat. Maryland actually had a situation last year or a couple years where major storm surged actually created the biggest problem by being a dam for the outflow for the precipitation on the land. So the flooding occurred because the surge made it effectively a dam and then the precipitation runoff flooded everything on the coast. Who would have thought of that? That is where Maryland is coming down trying to get its arms around the human health, safety, and welfare issues.

Then the fourth group is natural resources in resource based industries. Maryland has a reasonable sizeable agricultural and forestry sector but it has a huge bay community and economy and of course how to protect and continue to have as viable economic sectors those marine, agriculture and forestry industries is also a key issue of this. Preserving the natural resources in and of themselves but there is also the issue of the resource based industries. That's the sectors by which they are trying to identify and precede with options and most of those options are still in the planning stages, not only in identifying what they are, but their content because so little has been done on that front. For example, short term planning isn't linked to long term planning. Different agencies planning efforts – land use versus health and so forth aren't linked together. So a whole lot of this, at this point, I am sure will be recommendations to connect the dots. Another state that is undertaking some planning action is Washington. Washington has used a similar approach to what we just described here prospectively for North Carolina and also for what Maryland has done. The major exception there is that Washington also split off a separate water working group and that makes sense in the state of Washington because its water and snow pack really serves multiple critical purposes for their economy it is not just drinking water it is also a major agricultural industry and also its power sector which is heavily runoff and (inaudible). So three major underpinnings of their economy relate toward they also did an investigation in the water issues.

Finally I will just share a thought about Alaska which is still forming its work groups. In Alaska I am sure you have heard enough about their situation where they have tumbling trees due to melting permafrost. They have communities that are eroding including Native American communities that need to be relocated. And you can imagine the per capita cost estimates are between two hundred fifty

and five hundred thousand dollars per person to relate communities. That's a cost that may or may not be able to be avoided but to the extent that one can plan for it, it can at least be mitigated itself. And as a result of those dynamics in Alaska it is not politically feasible for Alaska to undertake an investigation of mitigation opportunities unless it also undertakes an investigation of adaptation opportunities. So you see that cart is really before the horse or in the reverse order from what we usually experience and anticipate less work on the emissions and then yet how we are going to adapt. How we are going to adapt, this is happening now and what should we be doing to try to mitigate the problem as well. I would indicate too that in identify how they are going to approach it in terms of technical working groups, Alaska is keeping the best wisdom of its state department, they will take that feedback and sort it out and then the state will identify what working groups it wants to emphasize and then we'll go from there with the process that Bill described identifying options, recognizing priorities and investigating those priorities.

And finally we had indications of interest in Florida which would be no surprise due to sea level rise and also in Arizona presumably directed to the fact that water shortages are looming under most climate modeling scenarios. So they want to get their arms around adaptation issues as well. So that is sort of a lay of the landscape a brief scan of where other states are at this point. Thanks very much for having us.

Mr. Garrou: Thank you. Are there questions for either of our guest?

Dr. Riggs: How is Maryland approaching this whole question of outreach in education of a public and political regime that wants status quo from coastal systems that they really don't want to talk about this? Have you dealt with this at all and how are you going forward to get a stakeholder involvement out there in public domain?

Mr. Colburn: The politics in Maryland have not been an obstacle at all. However, I appreciate the question because it is almost an admission on my part. I mentioned the planning side and planning for planning the other thread that falls through almost everything that Maryland has identified in plans to conduct at least their preliminary work carries through the final, heavily relates to public education and outreach. If they have 40 options at the end of the day, I expect unless they do a massive consolidation that on the order of 15 of them maybe as high as 20 will relate pretty directly to public education outreach. And I don't simply mean add to the public materials to the public, it's the sub-sectors of how do all the emergency responsive personnel communicate with each other on climate based events, catastrophic events even that kind of thing. Educating them to coordinate with this damming and outflow kind of issue is an example that we're putting under the heading of public education outreach at this point, very, very critical issue.

Dr. Riggs: Does the general population out there support this at this point and time or is it a long up hill battle that you're facing?

Mr. Colburn: No I think there is a high degree of support. I would yield to Tad Aburn to offer an at the site kind of feedback on that. But we haven't had push back or resistance at all. I would expect that any individual home owner on the coast would say yes I am all in favor except don't touch my sea wall and that kind of issue may come up because my sea wall may affect your frontage in a (inaudible) manner. So Maryland will have to work through those kinds of things. There is also a strong county and municipal government in Maryland that also has to be coordinated close to the state effort. So there is some push and pull there based on history but none about whether they should be addressing adaptation. Wrong answer, I'm sorry.

Representative Allen: Thank you Mr. Chairman this is sort of a follow up to that question. In what way is the development community involved as you're planning?

Mr. Colburn: They're reasonably heavily involved as stakeholders. There are builders on the stakeholders group itself and municipal planners and there may be others that I am not thinking about at this time.

Representative Underhill: Thank you very much you just made an illusion to don't touch my sea wall. Does that mean that Maryland does allow hardened sea wall barriers?

Mr. Colburn: It has in the past and there are some they are trying to move from a situation where that is not the solution and more of what they call softer and more natural barriers are used instead because frankly they are more flexible and adaptable and you don't run into that situation of oops the sea wall didn't work that time I guess we got to build it bigger, oops Einstein issue. In the harbor communities and smaller residential situations there are some.

Dr. Smith: Ken thanks for your presentation. I think it was touched on in your early presentation but can you go back and just talk a little bit more about the process itself as this particular group was established and can we request a list of who the participants are and just a little bit more about the actual process mechanisms that this entity is carrying in its work and if you know a little bit about some insight on some of the other places would be helpful too.

Mr. Colburn: Sure, I wasn't directly involved in Washington so I am not sure how they did that. In Maryland on their adaptation group the Department of Natural Resources is chairing that effort and it formulated the stakeholder group before we were involved with the effort so we didn't have direct input into that. Typically, on these efforts we do, but the only typical I can talk about is the mitigation side. We do provide input into the identification of categories of stakeholders. We don't know the individuals in the state so we leave that to folks convening the

effort. But it is important, let me site a Maryland example where the DNR had thought pretty concretely about the development community, had thought about the planning community, municipalities and so forth, they had almost completely omitted the health community and the emergency response types of folks. So we are building even now, much as Bill described with the 200 options, a list of conceptual categories that states may want to consider in assembling and conducting these plans. So that list will say have you thought of somebody from the building community. Have you thought of somebody from a water company, a power company so that your infrastructure elements are really there at the table because they need to be on adaptation? And then the process as Bill described, here is a set of options that we are aware from other states and other activities, what should be added to that list to accommodate adaptation most effectively here in North Carolina. Take that new and bigger list and say ok what are those options have the most residents, the most effectiveness, the highest priority in North Carolina and that list that is 200 are now 250 might then be whittled down to 40 or 50. And then with the technical work groups on a sector basis really dive into what will be involved with them, where do we stand now, what's the suggested direction and what would the policy actually look like. Would it be implemented legislatively or is it something for which already exist in executive authority and hammer that out and then submit those as recommendations at the end of the day.

Representative Harrison: Thank you Mr. Chair and thank you for the presentation. I was wondering more specifically about the coastal development management issues. It seems like most of these states that are working on this right now are in very much the preliminary stages and haven't actually gotten to the point where they are trying to make hard fast decisions on redevelopment and what kind of infrastructure, so will we be hearing about that in the future?

Mr. Colburn: Yes exactly – they are in the planning stages of what should be the policy by which they make those decisions. What are they underpinning and then I am sure there will be some struggles in the implementation process.

Representative Harrison: One thing specifically regarding Maryland, a part of the Chesapeake Bay, the agreement I think of six states were some of them involved in that or any of the other states involved in that adaptation effort or is that a regional effort there?

Mr. Colburn: They aren't at this point. The metropolitan Washington Council of Governments has been participating as an observer in the Maryland effort on mitigation and adaptation. So they are wise to it as a council of government but they are not undertaking similar efforts yet.

Mr. Urlaub: Thank you for sharing this with us today. I had a question about the adaptation group and the mitigation group or committees. Are the discussions around the policies and exploring policies and the science in the adaptation group, are you set up in a way that's informing back to the mitigation group for

them to possibly reassess or change some of the inputs into their own cost benefits analyses for the policies they looked at. Are you to that point in your process?

Mr. Colburn: I think the answer is yes and no but I can't claim credit for it, it actually goes to the state itself. In Maryland there is a commission that was established more like you all and it created a mitigation working group which is doing all the work that your CAPAG has undertaken and it also established a separate group of stakeholders there is an overlap. It's really different folk with different interest dealing with the adaptation issue. There hasn't been a cross walk to date except in a few specific conceptual issues and features but they both come together to the commission at the end of the day for recommendations to the governmental legislature. I haven't experienced any yet and that may be a function of where the adaptation process is in the game which is still only identifying its priorities is really where they are. In terms of anything technical cost related impacts where an adaptation decision would arguably increase mitigation problems with that kind of thing. Those are potential so I think what you're suggesting is to keep your eye open and indeed that is quite right.

Mr. Urlaub: Then specifically the four groups that are potential groups listed there where would you see energy come into that? For example, what comes to mind for me is rising temperatures raise the temperature of water that is going into a cooling tower of the power plant can cause power lines to sag more than that might have otherwise but they are not cooling as much and so on. And how in your process is there any feedback for seeing that kind of adaptation challenge and need for capital investment back into the evaluation of alternatives like energy efficiency?

Mr. Colburn: There hasn't been any – I don't think there is a resistance to it but it is important to distinguish as well I think between what one might call feedback loops or positive feedback loops because the vector that creates them has the effect of worsening the vector which creates even worse effects. So your example on temperature both from a cooling perspective with warmer water and with ambient air temperatures requiring even more air conditioning, those are positive feedback loops that if we keep doing business the way we are, we'll have more emissions which will worsen the problem which will create warmer water and warmer air. There has not been in the adaptation effort to date any thing as specific as saying how do we address greater sagging car lines or could we leverage efficiency more concretely on the mitigation side to avoid some of those outcomes but I think they are implicit. They are also sufficiently detailed that we probably haven't gotten to that yet in Maryland and may not in this process because at this point Maryland is still trying to get its arms around the issues well enough and it maybe that we are getting into a level of detail of infrastructure or even power distribution infrastructure but not to the level of detailing this is what should be done. Happily most of the utilities are aware of

these issues as well and are starting to already factor in adaptation - George would probably know best.

Dr. Riggs: You've implied that Maryland's way out in front of everybody else in this country, do you have any preliminary reports that would be available to us to help us lay a path and secondly are there other countries in Europe or Australia and so forth that are also involved in this to the extent that Maryland is that we can learn from?

Mr. Colburn: I would be pleased to share with you what we have and thank you for raising that because it is really a follow up to Dr. Smith's question. We would be pleased to share the categories of stakeholders that we've developed and the options that are being developed. They are all actually posted on the web. I didn't mean to imply that Maryland is light years ahead, it is just perhaps first or second out of the gate and it certainly hasn't crossed the finish line. In terms of the international Bill has far greater experience than I so I call on him for response.

Bill: Perhaps just a brief word about how the international community is treating adaptation. I think to date it is fair to say that most of the effort internationally on adaptation has focused on non industrialized or countries that are in process of industrializing, that is non annex one countries. Those countries that are not responsible for achieving reductions in their GHG levels - that is countries outside of Europe, Australia and the Eastern Europe. Now the reason for that is according to the IPCC most of the impacts associated with climate change are likely to fall disproportionately on those who are the least able to adapt. That is the poor countries, Africa and some countries in Asia and so I've been involved in a number of efforts that are looking at how can these countries adapt, places in Africa in particular? So I think that to answer to your question, most of the international focus has been on concrete actions within developing countries although much of the work there is inspired a bit by what industrialized countries think are the mechanisms that measures on possible policy action that could be taken for these developing countries.

Dr. Riggs: Just a follow up maybe a comment – I am aware that the UK is way ahead of most of us, I don't know if they are ahead of Maryland or not but the United Kingdom has done an awesome job at this and I believe Australia is out there and maybe even the Dutch and so forth. I think we can learn from what they've already done in those countries I was hoping you knew a little bit more about what was coming out of those areas.

Bill: Well you're absolutely right the UK has actually a government program on adaptation and it's very much a model for what countries in the developing world can do in so far as it tries to be a one stop shopping source for adaptation to climate change. That is what could farmers do if the rainfall variation is proving too problematic for the types of crops and other areas of the economy? So yes it is a very good example, the UK. I am not familiar with Australia and what they're

doing but I do know that the UK example in particular is one that is being looked at critically in large parts of the world.

Mr. Stephenson: One of the speakers I think had indicated that Maryland was the fourth most susceptible state to sea level rise and is there an indication what one, two and three?

Bill: You might be referring to the slide in which I showed the increase in sea level rise for three parts of the eastern coast. No. Well I think that North Carolina like its neighboring states is very much at risk associated with sea level rise. I don't think I did and I would not characterize it as a fourth most problematic state but it's definitely in an area of concern.

Mr. Profeta: I can check on that – I remember the information, I can't remember the citation but I can track it down. I believe the ranking was first most susceptible was Louisiana, second was Florida, third was North Carolina and the fourth was Maryland.

Mr. Colburn: It would sound right that it is a function of link of coastline and elevation above coastline over large areas.

Mr. Profeta: Dr. Riggs just gave me the back up that I'm right so I feel much better about saying that now.

Ms. Tompkins: Thank you Chair. Do you have any numbers or field for the trend of tourism being affected?

Bill: Well I think any time in a state like North Carolina where you have a very developed tourism industry along your coastal areas. Tourism comes to mind as one of the parts of the economy that could be really hit hard by changes in the coastal regime. In terms of any hard numbers in Maryland I can only say that they are looking at coastal areas in a very focused way as Ken was mentioning not only in what is there now, the existing infrastructure but also what the future stock would be in terms of infrastructure and the plans that would govern developing in the coastal areas..

Ms. Tompkins: How about the tax bases for beach property?

Bill: Not in terms of trends and changes no – the municipalities are quite concerned of course about that and so that is in the back of their minds as they participate in this process but (inaudible) for conclusions regarding trends no and I suspect that we are at an odd juncture where the economic trends driving coastal development are continuing even as the impacts of climate change begin to be felt and there will be some mixing of those two trends for some time, the next five years anyway.

Ms. Tompkins: Thank you.

Mr. Garrou: Thank you very much for your presentations.

Mr. Givens: We did not schedule a lunch break but at this point it seems necessary to do so. Before we do that, I indicated to you that we needed to reschedule the April meeting which is currently scheduled for the 16th the co-chairs and counsel have consulted and we believe that the most appropriate date will be Tuesday, 22nd that is the week following unless somebody has a serious objection to that, we will post that as the next meeting. Anybody have any issue with that? OK so the meeting scheduled for the 16th is rescheduled for 22nd, it will be in this room.

Mr. Garrou: Let's see if we can be back here at 12:50 to reconvene?

Lunch Break

Mr. Garrou: Called the meeting to order at 1:05 and called on Mr. Peterson.

Mr. Peterson. This is a familiar graph (**Exhibit H**) hopefully that shows the blue line of projected emission and the green line of the sum total of integrated CAPAG recommendations where they ought to be implemented. We also have developed and it is in the final report, but we have done a little bit more work to provide it more clarity is the transformation of that into a supply curve and this happens to be for the year 2020 which is one of the two analytical target years we use, the other being 2010. It shows going from left to right the dots are policy actions agreed to by the CAPAG and those that are beneath the middle black line are actions that potentially could on a net basis save money. You see a long stretch in the middle that are very close to zero and then a see starting at the right hand side that start going above zero. So this is what we call greenhouse gas abatement supply curve and that has not all but most of the 53 actions in it. Some are lacking because they were not quantified for one reason or another. Just by way of comparison there is certainly a lot of analytical work going on in many quarters looking at supply curves for greenhouse gas abatement. This is some recent work done by McKenzie and this work is in the process of being updated. This is using international data a slightly different set of methods for the year 2030 and it has a break point at a cost per ton of 40 yeros, I think that's 59 60 dollars US. I wanted to put this slide up so that you can see if this hadn't chopped off, the right hand side, what we're seeing over and over again is an "S" shaped quadratic function of greenhouse gas cost that shows plenty of opportunity for cost savings on the one end and then a long stretch that's at zero or low cost and then a stair step that goes up beyond that. So there is a lot of consistency in these supply curves world wide. We've run supply curves for many US states that look very consistent in terms of shape but every state is different and as a consequence the curves are a little bit different too. What we have begun to do is package things together so that you can have a more consolidated view of the CAPAG actions. This particular wedge graph is portraying the greenhouse gas reduction potential of actions in different sectors

in its draft because we only included in this graph the ones that had a cost per ton analyses done for them and so there are some actions not included here. But I wanted to isolate on the agricultural, forestry and waste sector that is one sector that had a long list of individual recommendations and because it covers agricultural, forestry and waste it really covers three different sectored areas. So it is more difficult to consolidate those individual recommendations into a set of thematic areas than it is most of our other options. But we've done that here anyway and we've consolidated into eight categories the specific recommendations of agricultural, forestry and waste to show how they would cluster together around areas that would logically be combined for implementation. You can see the whole package is a significant wedge in terms of reductions. I've highlighted with the green arrows the larger ticket items so immediately you see there is a set that are significant in size and there are some others that are small in size and this is just in terms of greenhouse gas production potential. We will be doing this for each of the sectors as well as providing some of the more specific notation for these consolidated wedges about what some of the key implementation barriers and needs might be in order for these to go forward. We certainly can also portray for each of these wedges and for each sector the individual supply curve or cost per ton for the individual measures. Again the take away point is there are some areas that cluster together and they are significant in size, there are a few other things that really are not and if you want to focus on the things that are bigger ticket items they jumped out pretty quickly. So this is a work in progress and I believe that we are scheduled to bring back a more detailed analyses along these lines either at the next meeting or in March and I'll be happy to take any quick questions.

Mr. Givens: Let me just comment with regard to what Mr. Peterson has told you. Two things, first of all, if you all have particular items in the CAPAG recommendations that you want him to evaluate in more detail or provide you with additional information, let us know so that we can have whatever it is and we can offer that will help you in advance of the March meeting. The other thing, I'll be talking to some of you individually, I have begun to focus on the questions of how we transition from the recommendations which are broad to actual draft legislation and if any of you who have thoughts on sources of drafts with respect to any of the proposals that are under discussion, we would be glad to see them.

Mr. Glaser: Mr. Chairman, thank you. Not a question particularly on this topic but one of the things in advance of the meeting today, one of the things that I was looking for is any source data or any information on what's taking place in developing countries, specifically Brazil, Russia, India and China relative to discussions like what we're having in Maryland and like what we're having in North Carolina. Do you know of any source that is a good source for global climate change studies or actions taking place in those countries?

Mr. Peterson: The Intergovernmental Panel on Climate Change has a chapter devoted specifically to mitigation or abatement strategies and lots of back up documents that include exactly that kind of data. The status and evaluation of

efforts taking place in other countries including the non-industrialized or emerging economies for developed nations. So that would be one of the best immediate sources. A little bit of that information has been included in this McKenzie work here, this is North America, Africa, Latin America some of Asia; but there are certainly plenty of sources but I think the starting place would be IPCC because there is a formal mechanism for gathering or reporting of that data there. That data is not particularly current or complete in comparison to a lot of other information. Dr. Dougherty is not here at the moment but he does a lot of work in those countries and we certainly could access specific studies for specific countries if you are interested.

Mr. Garrou: Just to add a little bit to that – I've looked at that study, I think the one I saw was a (inaudible) graph and I think this is the same one that McKenzie did and it is very informative. It is very well presented, got a lot of information in one place.

Ms. Preyer: Just a comment on George's suggestion and thank you for the opportunity to maybe provide some ideas about recommendations we would like to see more detail on because time is moving fast and it seems like it will be smart for all of us on the Commission to look hard at that giant package and do some narrowing of things that would be good to talk about in March. Hopefully we will do that and thanks for the offer.

Mr. Givens: Just one additional comment. Mr. Glaser's point about what is going on in the developing world is the exact response to what I was saying this morning. We will note that and pass that along to Dr. Pachauri – he is our source and we are going to have an hour with him so we reiterate, folks who have questions that are particular to the work of IPCC are encouraged to get them to us now or as soon as you can but they will be conveyed to him and we will make an effort to have him prepared to respond to that type of question.

Mr. Slocum: Tom as you move forward on finalizing the CAPAG report I hope that you will also look at the critique from the Beacon Hill group on cost benefit analysis and look to address at least some of the comments that were contained in that study.

Tom: We would be happy to. We looked at that some time in the past when it came out and received a very immediate response from our research team. We have a couple of different universities that looked at it and they would be happy to provide a comment on that. It doesn't affect the results of the process at all.

Mr. Garrou: Thank you Mr. Peterson for your presentation. Our next topic is the presentation of a report on the Impact Measuring the Impact of Climate Change on North Carolina Coastal Resources from Christopher Dumas who is an associate professor at UNC Wilmington. Thank you, sir.

Mr. Givens: As we introduce Mr. Dumas I wish I had given a little more emphasis to this at the beginning. What we are going to hear now is the cost of doing nothing which is the other side of the cost equation that doesn't often get looked at.

Mr. Christopher Dumas: Thank you Mr. Chairman, thank you Commissioners for allowing us to present the results from our recent studies. This is a joint study by several professors (**Exhibit I**) at UNC Wilmington, East Carolina University, and Appalachian State University and we appreciate the opportunity to present our study to you. This is a project that is attempting to look at the potential vulnerability of North Carolina's coastal resources to climate change. This is one of several studies that were funded simultaneously to look at potential impacts of climate change in particular regions of the United States. So not only is there a study like this that I'm going to present today about North Carolina there are also studies on several other regions that have produced or are producing similar reports. Here is a study on Alaska's potential impacts of climate change in Alaska and also I have another one on New Mexico. These are finished, others are still under way but ours is just one of sort of an effort to take the information that we have on global climate change and try to bring it down to a more regional level. These studies are funded by the National Commission on Energy Policy and the Bipartisan Institute out of Washington, DC. Again this is a joint work, East Carolina, UNC Wilmington, Duke Nicholas Institute of the Environment, Appalachian State. Professor Bin is an economist at East Carolina that worked on this study, I worked on this study myself, I am an economist at the University of North Carolina at Wilmington and I might just say that Wilmington is my home town. I am a North Carolina native so potential impacts on coastal resources are very personal for me as well as an issue professionally. Dr. Pouter from Duke University Nicholas School, (inaudible) was unable to be here today he is in Germany apparently working at the (inaudible) Institute for Climate Impact Research. Dr. John Whitehead is at Appalachian State University also worked on this report. The report is available online and I'll have information about that full report not just the glossary summary that we're handing out today. The full report is available online for download and I'll give information about that at the end of the presentation. This is one of several studies under way here is a list of the other studies that are under way, one that I am on impacts of permafrost melt and infrastructure in Alaska. One of the impacts of climate change and water resources in New Mexico and adaptation policy, impacts on forest and air quality in Tennessee, risk to Florida coastal property, impacts on water supplies in Idaho, and impacts on forest in the Upper Rocky Mountains, so our studies on the coastal North Carolina but the efforts are under way to measure impacts at the regional level across the US.

One problem that we are all familiar with today climate change, we have significant impacts on North Carolina coastal resources due to sea level rise; our potential increase in erosion and increased hurricane activity intensity. As you know, extensive development in the coastal zone in North Carolina in recent decades has put more people and more property at risk. Our report focused on

two potential types of impact, sea level rise and an increase in hurricane intensity. Sea level rise can lead to the loss of beaches or beaches for recreation and for shore fishing, also loss property, loss property value damage to infrastructure also loss to recreation benefits, recreation tourism benefits there was a question about that earlier. We've got some information on that to present at this time. And we also have another category of potential impacts hurricane intensity increases. So if our hurricanes become more intensive due to climate change it impacts our business and tourism is interrupted. Agricultural losses damage to forest and potentially also to commercial fishing.

Climate models behind the analyses – the climate model physical science portion of the report was conducted by Dr. Pouter who is in Germany now, so I am going to be presenting this information but I am not a climate scientists, I am an economist. So I am least familiar with this information, I'll just run through what I have and any detailed questions you will probably need to contact Dr. Pouter. We used climate model results from the IPCC third assessment report - the fourth assessment was not available at the time we did the study. I would like to mention that this is an initial look at potential impacts of climate change in North Carolina. We only had six months and $50,000 to do this study. We had no money to gather additional data, we had to use existing data and so this is what we were able to put together from existing data to give an initial snap shot of some of the most (inaudible) impacts might be. We used climate model results from the third assessment. From that assessment we used mid range numbers from the results of over twenty global climate models covered in the IPCC report and there is a list of lots of different climate models, if you're a climate scientist you might see your favorite climate model in there. We looked at all twenty models and tried to pick mid range estimates of changes in precipitation and temperature and sea level rise based on those models. We used the sea level rise inundation model using an eight side rule for connectivity, I have no idea what that means, see Dr. Pouter. They have several studies one under review and others they have published previously about modeling sea level rise that uses light hour elevation data and generated a raster surface, binary flooded. Not flooded raster surface basically means for different property locations along the coast we can determine based on the sea level rise scenario whether certain property parcels were flooded or not flooded as a result of gradual sea level rise. Also there is a separate storm surge model that looks at whether properties might be flooded due to storm surge or intense storm surge due to climate change resulting from hurricanes.

North Carolina is especially vulnerable to sea level rise because our topography is so flat. A one foot rise in sea level can cause inland moving of the shore line by 2,000 to 10,000 feet in some locations in northeastern coastal North Carolina. In addition to sea level rise, we also potentially face the problem that our area of shoreline is also subsiding. So the same time that sea level is increasing our land is slowly sinking. That effect is also accounted for in the model but the subsiding of the shoreline and the increase in sea level rise to obtain a net sea level rise in our area. Here is a shot of the land area at risk to sea level rise

under our different scenarios by 2100. The land at risk is in pink, red and dark red unfortunately I don't have a good shot zoom in on the coastal barrier islands that a lot of large portions of barrier islands are at risk. As you can see the impacts are more pronounced in the northeast where the topography is flatter and less pronounced down in the southeastern portion of the state where the land rises more quickly from the sea. A lot of the coastal barrier islands from the northeast end and the southeast are impacted by sea level. As far as hurricane intensity the physical model behind that we used a modified (inaudible) wind speed model to generate our base line wind speed intensity estimates. We ran hurricanes three times with hurricane tracking information from Hurricane Fran.

We downloaded from the National Oceanographic Atmospheric Administration website. We chose to look at Hurricane Fran – potential impacts of what if Hurricane Fran which folks in North Carolina are familiar with, what if Hurricane Fran became more intense in climate change. We strengthened Hurricane Fran by an amount that the climate model suggest might happen, what if that same hurricane hit but only it was strengthened due to climate change? What would the additional impacts be? We chose to look at that because we thought that was a concrete scenario that people could relate to when we're presenting our results. Of course the impacts of increased hurricane intensity would vary depending on exactly where the hurricane hit and what (inaudible) across the state. The many different possibilities they're modeling methods you can use to look at that, your Monte Carlo simulations and that kind of thing. But given the information that we had at the time and our time I do not have time to do that, we thought this would be a way to measure something that would have residence with North Carolina citizens. Scenarios were based on estimated changes in hurricane intensity according to a study by Newsome and (inaudible) that looked at potential impacts of global warming on storm activity in both the Pacific and Atlantic Oceans and we estimated changes in hurricane formation in our area off the Atlantic Ocean and the area where hurricanes are generated and then we estimated that wind speed, that was to get at our base line hurricane wind speed distribution across North Carolina due to Hurricane Fran.

Then we said what if global climate change happens, how much of this wind speed increase when you use the magic seed spending model to estimate potential increase in hurricane wind speed and distributed those increases a percentage basis spaced across the state as the simulated Hurricane Fran role strengthen Hurricane Fran roles across the state. So this track of Hurricane Fran in 1996 that is the track we're looking at for our global warming affected Hurricane Fran. Hit just south of Wilmington and then moved to the northeast across the state. It had impacts along the state but impacts were most intense down in the southeastern portion of the state.

These are some results of the model that look at what was the base line hurricane wind speeds in different counties in North Carolina looking at four example counties, Bertie County in the northeast, Carteret County, Dare County and New Hanover. What were the wind speeds in those counties caused by

Hurricane Fran and then what would the wind speed be under climate change scenarios? Even though Hurricane Fran was a category three hurricane, it only had category three winds in the eye wall. As you move out away from the center of the hurricane the wind speeds diminish so the wind speeds that are experienced by any particular county depends on where that county is located relative to the track of the hurricane. Some of the counties that we chose to study as examples had less than category three base line wind speeds as they were less affected by Hurricane Fran.

So with this physical science background context we are going to consider the impact of climate change on coastal real estate, coastal recreation tourism and general business activity, agriculture and forestry. We also considered commercial fisheries but there was very little information available on the impacts of hurricane for commercial fisheries so we are unable to present any results for commercial fisheries at that time. We utilized that range of mid range for sea level rise and hurricane intensity increases, not the best or worst case scenarios from the climate models mid range predictions. Our study assumes that no mitigation or adaptation is taking place so we are essentially estimating vulnerability, what might happen if we do nothing.

We had some great presentations earlier today from folks who are thinking about mitigation and adaptation, we're saying what if we don't pursue that and we allow climate change to happen, what might be the impact? I'll begin with recreation impact – this section of the report these results were developed by Dr. John Whitehead of Appalachian State. We have two types of recreational impacts that we looked at – beach recreation and also fishing. So there is beach recreation when you're sunning on the sand and swimming and then there is fishing. For the non fishing recreation, the beach sunning and swimming, we only have good data from southern North Carolina beaches, so for basically Morehead south. We have this data due to another study we did for the Corp. of Engineers a few years ago when we collected onsite survey data, mail and telephone survey data, on recreation that's on these beaches. So we had readily available data we could use to estimate potential impacts here. Similar data are not available for the Dare County and northeast North Carolina beaches. We were not able to estimate impacts there. So the recreations that I present are only for the southern North Carolina beaches, those northern beaches would have additional impacts beyond what I am going to present today. So here is what the sea level rise models indicate with respect to impacts on beach width. We've got some current beach width that's the 2003 column at various beaches in Carteret, Onslow, Pender, New Hanover and Brunswick Counties, then what the beach widths might be under sea level rise from the climate change scenarios in 2030 and 2080. We projected estimates of impact of 2030 and 2080 for the purposes of reporting. So as you see a number of beaches if we do nothing the beach would go to zero, so if we do not re-nourish, if we do not undertake some other types of activities we could lose significant numbers of beaches along the North Carolina coast.

Representative Wilkins: Could we have some idea of what the standard tide was here?

Mr. Dumas: The standard tide I don't know. Are you talking about at what point on the beach would beach be measured?

Representative Wilkins: Yes.

Mr. Dumas: From the line of vegetation on the dune down to mean high tide. So the base line beach width information, the 2003 column, that information is from the Corp. of Engineers we asked them for their beach width and used that in the modeling.

The point here is that the potential to lose a significant amount number of beaches as have a significant reduction in beach width if nothing is done and of course, even if you don't lose the beach if you have a significant reduction in beach width that significantly affects recreational opportunities, that makes beach recreation more congested and also of course if you lose your beach width the beach that protects your structures, the structures are more vulnerable to storm surge.

Impacts on recreation tourism – it provided additional information on economic modeling behind the recreation and tourism results if you are interested. I think Dr. Phaneuf from North Carolina State University could also give you lots of additional information on recreational modeling. He is one of the experts on that Dr. Whitehead is as well. But due to effect of the bottom line loss recreational value to local southern North Carolina beach goers estimated to be about ninety three million dollars per year by 2030, two hundred twenty-three million dollars per year by 2080. Now this is loss value to the recreations themselves. This is a measure of the production in value because they are not able to go to the beach to recreate or they have to go to other less preferred beaches in order to recreate. The model takes into account the possibility that if a certain beach is loss due to erosion, beach goers may still take a beach trip but just may go to some other beach that has been less affected. The model takes into account the substitution affects across beaches to make these impacts. In terms of production annual spending by non-local beach tourist visiting North Carolina, the reduction in out-of-staters coming to the beaches and reduction in their spending could be as much as 16 percent by 2030 or 48 percent by 2080. This significant reduction in tourism as you would expect if we lose these beaches. The annual spending amount calculations we only calculated for non-local beach tourist under the assumption that if you were a local beach visitor if you did not go to the beach you would do something else with that money, go to the movies or something else instead that still might provide economic stimulus for the region. So we only looked at non-local beach tourist to calculate the economic impact on local businesses due to reduction in recreations.

Dr. Eggers: I am a little bit confused, lost recreational value to local southern North Carolina beach goers. You said it was lost value to the individual but then you said that might go somewhere else and spend the money, so is it a contingent valuation thing you did because they are going to a beach that's not as good?

Mr. Dumas: Yes they are going to a beach that is not as good or we're not going at all. So we assume that there is no change in expenditures by local beach goers they still spend that money. There's no impact on local businesses but they have a reduction in value to them because they are undertaking a recreational activity that is less preferred. They would have gotten more personal value out of going to the beach, but if the beach is not there they will of course do something else. So they're still spending money but of less value.

Now we look at impacts on shore fishing – for shore fishing we do have information for all beaches throughout North Carolina. Twenty-eight beaches and 22 piers and information for the shore fishing impact estimate is from the National Marine Fisheries statistics survey and that provided the data that we needed to estimate impacts on shore fishing. If you lose some beach area we assume and used the model to estimate where the shore fishermen will go instead to other beaches or move to the piers and so the estimates of loss value take into account the fact that they will do their next best thing if their beaches are affected they will move to a substitute beach or to a pier and continue fishing. It's just that they enjoy that less than they would fishing in their primary location. So based on the date of the analysis the loss recreation value to local shore anglers fifteen million dollars per year by 2030, seventeen million dollars per year by 2080, these impacts are for all North Carolina beaches.

Coastal real estate – this portion of the study was conducted by Professor Bin at East Carolina University. Again we focused on four counties, here is a map of the four counties, Bertie, Dare, Carteret, New Hanover, these results only apply to property values in those counties. We have data on property values from the county tax office, parcel level data for each individual piece of property. We also have high resolution light elevation, ground elevation data to identify areas that would be inundated by sea level rise or storm surge. We also have other characteristics of property parcels distance from the shore, etc. measured using geographic information systems from GIS data. For example, here is some of the data from New Hanover County, property value of the town you're in, size of the house square footage, age of the house, bathrooms, fireplace, ocean front or not, down front or not, many different types of information used to estimate what the value of the house and the value of the property and how much of that value might be lost, what value of the property would be lost if it were in there? The picture of the (inaudible) data shows elevation data, looking from the ocean, looking back toward the coast and showing the elevation of the houses and trees and the ground.

Here are some examples of the geographic information system real estate data we've got the elevations data, ground elevation data at the top right, distance from the shore line data at the bottom left and tax parcel Centro data to the bottom right. Centro is the central locate geometric center of your piece of property. So as sea level rises or storm surge happens if the geometric center of your property is covered by water, then we consider that parcel flooded. We considered several (inaudible) scenarios, again looking here at 2030, 2080 a low, medium and high in projected sea level rise so in 2030 based on our global models, projected sea level rise could be anywhere from 0.1 to 0.2 meters along the coast by 2080 it could be from 0.3 to 0.8 along the coast. Here are some inundations flooding maps for 2080 the high scenario so out by 2080 you look at the areas that are shaded dark blue and light blue. Dark blue those are the areas that could be flooded again. This map has some call outs that you can see the effects on the coastal barrier islands in the bottom right as you can see the barrier islands are significantly affected and harder to see in the large scale map to the left but you can see there are some significant affects. Also there is some property that is affected well inland around the estuaries and sounds and also up the Cape Fear River and its tributaries. These (Inaudible) properties value model a common type of model economists use to estimate the impacts on property values, estimate the loss of value due to flooding. Current property values are subject to sea level rise in New Hanover County. Look at New Hanover County as an example we have similar results for the other three counties in the study. On the left you can look at the first column property value, current property value that's in millions. New Hanover County has 16 billion dollars in property value with a split between residential and non-residential value and then you can look at the loss property value for the various sea level rise scenarios in the columns moving to the right. So if you look at the far right column that is the worst case scenario out in 2080 New Hanover County could move 227 million dollars in property value or about1.4 percent of the existing property value in the county, of that about ¾ residential and ¼ non-residential losses, 1.4 percent of the value of the property and 1.3 percent. Now the percentage of coastal property or the property on the barrier islands loss is much higher, that percentage is a total property value in the county.

Here are similar results for Dare County and if you look at the top right percentage of the total county property value loss it could be as high as 19 percent in the worst case scenario, or 3.5 billion dollars in property value. Dare County is very low elevation and has significantly greater impact than the counties to the south like New Hanover County where land elevation rises much more quickly as you move from the sea inland.

The estimates of the property value at risk in the future in which year the damage occurs impacts the estimate of the property value loss and also the discount rate that you use. So here is a table that shows the potential impact of the economic discount rate you used on the damages that have been filed in the future. For example, look at residential property value at risk to New Hanover County, look at the bottom row, the undiscounted measure of property value at risk under the

worst case scenario the bottom row 2080 with high sea level rise, 254 million dollars with no discounting that's the value of damages occurring in 2080. However, if you take those dollar damages occurring in 2080 and discount them to present day dollars instead of being 354 million it is about 60 million dollars in damage. If you use a 0.7 percent discount rate the far right column. So the discount rate that you use affects the present value of damages that might occur in the future. So the value of property at risk to sea level rise in just four of the coastal North Carolina over the next 75 years is potentially almost seven billion dollars, the present value of the loss residential property in 2080 is 3.2 billion and when you discount at a rate of two percent. The present value of loss non-residential property is about 3.7 billion when you discount at a rate of two percent. If you discount at a higher rate then the losses are smaller.

I'm going to talk about impacts of increasing storm intensity on coastal North Carolina. This is my section of the report – again we are going to look at the impacts of increasing storm intensity in just four counties. You look at those four counties and look at the track of Hurricane Fran and say what if a hurricane with a track similar to Fran came through the state but was more intense and was increased intensity due to climate change, what might the impacts be on wind speed in the four counties? The base line wind speed caused by Hurricane Fran in the four counties are shown in the first column, tropical storm in Bertie County, a category one in Carteret, tropical storm in Dare and category two in New Hanover. If we have a climate change occur by 2030 and 2080 if that same storm came through that was more intense, you would have an increase in wind speed in some of those counties. Bertie County not much effect, tropical storm winds all the way across even with climate change due to the particular track that Fran took in this particular scenario that we're investigating. If we had more time and more money it would be much better to do a Monte Carlo study with all possible tracks of hurricanes across the state and estimate probability distributions of damages and that type of thing and that would be a much better study because of the initial snap shot.

Carteret County - if Hurricane Fran came through again with more intense instead of experiencing category one winds it would experience category two winds. New Hanover County did experience category two winds on average across the county and it could experience category three winds, so if the hurricane came through and intensity was increased what would the additional damages be? In our study we are going to assume that the frequency with which hurricanes strike North Carolina remains unchanged under climate change. Now when climate change occurs it could both increase storm intensity and increase hurricane strike frequency, the number of strikes per year or decrease the number between strikes. But the information that we had at the time did not provide information that would allow us to estimate changes in hurricane strike frequency even though we wanted to do that we discussed that extensively we could only estimate changes in intensity. If you assume that the hurricane strike frequencies remain as they have been based on historical record in North Carolina, you can see in the last 150 years you've been struck by 23 category

ones, 13 category twos, 11 category threes, and so on, Hurricane Hazel our category four that struck in the early 50's. From basic information calculate the annual frequency, the annual probability of annual chances that North Carolina will be struck by a hurricane of a given frequency. We're looking at hurricane category three, Hurricane Fran and saying what if category three hurricanes strike with the same chances every year about seven percent for a category three based on historical record but the hurricane strikes become more intense.

The first category of damages is business interruption. So business interruption are damages that result when you have a hurricane strike that is not a major storm, it is not a category four, not a category five, you don't have buildings being knocked down instead you just have downed power lines, downed trees, flooding that prevents businesses from operating as normal for a given period of time. By chance we've done a study on the economic impacts on business interruption of low intensity category hurricanes in North Carolina of a few years ago. We looked at Hurricanes Bertha, Bonnie, and Fran categories one, two and three and we did a survey of businesses in North Carolina asking how many days did it take them to return to full normal business operation following strikes by each of these hurricanes. So by business industry type we could estimate how many days it would take to return to full operation. Now this is important for the current study because our estimates of the impacts of more intense hurricanes on North Carolina involve switching among categories of low intensity storms. Some counties go from category one to category two, some from category two to category three, so most in this state we could estimate what are the additional number of days that businesses might be out of business having their business interrupted due to hurricanes becoming more intense under climate change. In addition to these data we also have information on the dollar value of output per day by county for each of these industries. Those data also take into account the fact that different counties have different industries present and those different industries present in different magnitudes. Dare County might have much more in both buildings for examples than Bertie County so we do account for the difference in industry mix across counties.

Benefit interruption losses – just four North Carolina counties, Dare, Bertie, Carteret, and New Hanover. We are not including agricultural, forestry or commercial fisheries at this point. So what might an impact be due to an increase in category hurricane three, Hurricane Fran severity only? So it could be a 34 million dollar increase in business interruption damage per storm per category three impact by 2030 and 157 million dollar increase per storm strike in 2080, just in these four counties, just for business interruption, just from category three hurricanes. If category fours and fives also become more intense and there will be additional damage for that. Also this assumes that it strikes frequently or remains the same that hurricanes also come more frequent and that would increase the damage further. Cumulative impacts for 2004 to 2080 given the probability that we are struck with category three hurricanes every year what might the impacts be by the time we get to 2080? Just due to the increase in intensity from climate change - 373 million dollars assuming no population or

income growth along the coast. If you use the state's projections of population and per capita income from the coast, it could be 1.4 billion dollars accumulative impact due to increased intensity category three storms on just those four counties along the coast. I know that statement had a lot of caveats in it but we are restricted by the limited amount of data. We hope to expand these results to account for change in hurricane frequency and consider more counties and more detail in the future.

Impacts in agriculture – there was some information available for North Carolina Agricultural Statistics Service on the impacts of hurricanes that have struck North Carolina in the past. So for example in category one hurricanes, there have been multiple strikes on average, a category one hurricane has 50 million dollars in damage, category two – 200, category three – 800 million dollars in damage. So you can see that potentially a change in hurricane category due to global warming, a change from category one to category two. It could mean significant additional damage to agriculture in the coastal region into hundreds of millions of dollars per storm strike.

Impacts on forestry – less information is available on the forest sector. There were two main studies that I was able to use that were produced by the North Carolina Forest Services Timber Damage Assessment. A study on the impacts of category two Isabel in North Carolina which did 578 million dollars in damage and category three Hurricane Fran that did 1.5 billion dollars in damage to (inaudible) to forestry in North Carolina, so based on this limited data you say well what if storm intensity increases from category two to category three, you could have hundreds of millions of dollars in additional damage to forestry in the state. That incremental impact may be smaller based on these data because of the technicality that Fran may have cleared out some weaker trees leaving fewer trees to be damaged by Isabel that came later in time; if so the incremental impacts of an increase in hurricane severity would be smaller than is indicated by looking at these numbers. I am just going to give you a ball park estimate of the significant impacts of increases in hurricane intensity on forestry. If you look at the potential impacts on climate change on North Carolina's coastal economy potential impacts of the next 75 years, loss recreation benefits could be on the order of four billion dollars. Property at risk and sea level in just four counties could be on the order of seven billion dollars, business interruption, agriculture and forestry losses could also be substantial. And again this assumes no increases in storm frequency, we look forward to results from climate and weather modelers that are improving the modeling and can give us an estimate to changes and frequency. Some of that work is going on at some of the universities in the western part of the state. Also these are potential impacts assuming no adaptation or mitigation. These results facilitate comparison of policy cost in benefits. Avoiding potential impacts that I am presenting here today would be one of the benefits of adaptation and mitigation costs.

So if you look at the cost of some of the adaptation and mitigation policies that have been identified by some of the speakers earlier today, look at the cost of

those and you think well what might we be getting for implementing these adaptation and mitigation policies, what might we get from incurring these costs? Well what you would get is you would be avoiding some of the damages that I've discussed today. I am very happy to report that the University of North Carolina Research Competitiveness Fund has recently been established and has just approved funding for additional research on this topic, North Carolina coastal hazards, economic implications of severe storms and sea level rise, a significantly larger budget and time line with respect to our project for a 288 thousand dollar study. It is joint work – East Carolina University is the lead, Professor Steve Culver and Stan Riggs are the principal investigators and also includes investigators from Western Carolina University, Appalachian State University, UNC Wilmington and the Coastal Studies Institute, it's a North Carolina wide effort. That report was due with initial results not reported, we will do that this summer and results are already under way. I had a one page handout (**Exhibit J**) that I passed around showing the projected deliverables from that report. If you're interested in what topics that report might consider you can look at that one page sheet. Not only does it look at some of the items that I've presented results on today, it also considers traditional issues like highway 12 and the Bonner Bridge and historical sites and (inaudible). So there is not only information on extending our results but also new types of impacts to be considered by this new study. If you're interested in the full technical report instead of just the four page glossy (**Exhibit K**) I've passed around today, that can be downloaded in its entirety from the website at Appalachian State. I would also like to say that North Carolina is left with a lot of work in natural hazards and climate change and we have a lot of folks working on this. Not only the folks I've mentioned today in this presentation, let me also point out the Natural Hazard Center at East Carolina University. They have gathered together a lot of great scientists and economists there and doing a lot of great work on coastal hazards, economics and physical science. In addition, the Duke University Nicholas School not only has great physical scientist, one of who was a member of our team and also some great economists including Dr. Marty Smith who is working on the dynamics of erosion, taking dynamics and we're expecting much more details than we've been able to look at in our initial report. North Carolina State has put on a great national scale workshop on economics and climate change here in Raleigh this past fall. We had folks from all around the country coming and presenting information on economics and climate change in the region. One of the highlights of that workshop in addition to what is going on in our state was a presentation by Professor Michael Hanemann from the University of California in Berkley. He heads the Center of Study for Economics for Climate Change in California and if you're looking for additional information on what is going on in California in the economics climate change I would highly recommend that you goggle Michael Hanemann at UC Berkley and find out what is going on there. And finally a commission member asked a question of the last speaker about where you might find additional information on economics of climate policies in other countries and developing countries? I might just mention Resources for the Future, another think tank located in Washington, DC that does a lot of work on natural resources and environmental economics. They have a lot of great work

on economics of global warming and climate change, not only US but around the world and they can provide additional information and additional links to other researchers around the world. With that I conclude. Thank you.

Dr. Riggs: Thank you very much for your summary presentation. I would like to ask two questions. One more specific that deals with growth rates on the coastal counties is outrageous, 40/50 percent annually so that if we project forward to 2030 and 2080 assuming that we have no limits to grow as we proceed, not only do the increasing population but the changing economics of who is building there and the big industries that are coming in and the size of the mega houses etc., it seems to me that your numbers are incredibly conservative. Have you taken into consideration or do you plan to take it into consideration those changing dynamics of growth that's question number one. Question number two, I would like to hear what you would do in phase two here assuming we can make money come available what is your next step and how do you expand this into something more than just a snap shot?

Mr. Dumas: With respect to the changes in growth over time there are several dimensions to that issue. One is that we calculated all of our results so assuming no growth to population per capita income and assuming state projections and it is true that those projections could be optimistic in terms of population and per capita income if you assume there's been some caring capacity because we run into limits. So we hope that our results that we provide sort of span the range of possibilities with respect to income growth and population growth. And we expect an increase in value that is why we also included changing per capita income. So our projections not only include for change in (inaudible) growth population but also per capita income to get us that wealth effect the fact that people might do due to increases in income build larger houses as they are doing along the coast. We also grow because of the county economies but we do not change over time based on change per capita income. We grow in value with the industries in each of the counties over time. We do not change the industry mix. Of course industry mix is likely to change over time but that is difficult to predict so for the purpose of our study we just withdrew industry mix per capita income. With respect to changes, additional issues about investigative (inaudible) budget and additional time there are several. One is we would collect beach recreation information for northeastern North Carolina similar to the type of information we had for the southern beaches. The Corp. of Engineers has such a project and ready to go. We helped them design it, we have the survey. We have the sampling plan already to go and the Corp. was about to do that but then their funding got cut. So we hope to implement that study so that we can also estimate the impacts on beach recreation in the northern part of the coast. As you know tourism recreation is a large and growing important industry. With respect to property – property value and property value at risk due to sea level rise and storm surge there are several things. One would be to extend our results to all coastal counties not just the four counties we considered, that would be one thing. The next thing would be to look at better modeling of storm surge. We feel good about the sea level rise modeling that we have done, the storm

surge modeling could be improved based on existing information based on state storm surge maps and (inaudible) model which you may be familiar with and we could improve the storm surge modeling. Also we would really like to (inaudible) property with respect to business interruption, effects on agriculture, forestry and also potentially property. We would really like to get our hands on better storm frequency information. If climate change happens how is it likely to affect the annual chances of different areas being struck by different intensity hurricanes? So essentially we would like the weather modeler to provide us with shifts in the wind speed distributions that North Carolina might experience over time due to climate change. If we had those shifts in wind speed distributions we could then calculate estimates of probabilities in terms of types of damages happening and confidence intervals and those types of things that might be valuable to policy makers who are in risk management situation. We all know that there are no certainties here just the climate are large complex dynamics (inaudible) system and it is difficult to predict. So we are trying to manage risk to the extent that we can provide estimates of probabilities and chances and complex intervals that make our results more useful in balancing benefits and cost of managing risk.

Representative Underhill: Thank you just one quick question. You mentioned the workshop that was last fall and opportunity to look over those materials if we were not there. Could you elaborate on that again, I'm sorry I just didn't follow on how to do that? Is it online?

Mr. Dumas: Sure, the workshop last fall hosted by North Carolina State University and they invited economists from across the country to talk about recent studies of economic climate change in their region and at the national level. You can find links to that workshop at the North Carolina State University Department of Economics or Agricultural Economics more likely. They have an environmental economics program there.

Mr. Slocum: Just a couple of comments with regard to the forestry sector. When Hurricane Fran hit it was in a period of pretty unusual circumstances. The hurricane hit following a fairly prolonged wet period, soils were saturated and that really exasperated the damage from the hurricane. The other thing is timber damage from a hurricane is dependent on a lot of different factors, timber size, age, soil type, soil moisture all have a dramatic impact and I would just caution against trying to model the forest as a uniform entity with regard to storm damage because it is not uniformly susceptible and your damage is not going to be uniform. In fact it is very seldom that you have state wide damage from any single storm.

Mr. Dumas: That certainly is the case so we were just trying to look at what order of magnitude effects might occur. We had changes among hurricane category based on the existing information. We did not undertake any detailed modeling on the forest sector because we didn't have the information to do that. As you point out, not only would the impacts be affected by differences in the physical environment, the biological environment at the time, that the value of the

trees lost would also be affected by what is going on in the lumber market and the housing market and all types of things that effect the price per board foot for different types of trees. So the value lost depends on many different things and it is not only location specific but it is also time specific in terms of different values market would place on. Better to be hit when you're in a recession than when you are not I guess.

Mr. Garrou: Our next presentation is from Mr. Travis Madsen, who is a policy analyst with the Frontier Group.

Mr. Madsen: Hi my name is Travis Madsen. I am a policy analyst with Frontier Group which is a nonprofit organization and we have offices in Boston, Baltimore and California which I'm visiting you from. So I appreciate the opportunity to come out here and speak to you about a report that I've just written. Frontier Group produces policy ideas and research in support of cleaner and healthier environments and a fair and more democratic society. Since 1996 our staff includes about 100 research reports addressing various topics from energy use to global warming to public health. I am here to talk to you today about our recent report called "When It Rains It Pours Global Warming and the Rising Frequency of Extreme Precipitation in the United States" (**Exhibit L**). First I am going to talk briefly about what climate scientists expect global warming to do to precipitation patterns in the United States. Then I am going to briefly talk about our study which shows that some of these impacts are already visible. I'll talk a little bit about the impacts if this trend continues in the future and then present some brief policy recommendations.

As you heard scientists are using climate models which predict what might happen in the future of different scenarios for global warming emission. As far as precipitation patterns go they expect that global warming will have a huge general effect. Some parts of the United States will receive greater amounts of rain and snow fall during the course of the year. Some parts of the United States will receive less but in general across the whole country scientists expect that more of our total annual precipitation will come in a smaller number of storms during the year. In other words when it rains it's more likely to rain harder. At the same time in between these more intense rain storms scientists expect there will be longer periods of dry weather. Let's talk about the precipitation intensity – the idea is that when it rains it's likely to produce more rainfall. This figure that is up on the screen is from the latest Intergovernmental Panel on Climate Change Report. On the left hand graph there presents precipitation intensity over time, the left side of the figure is historical information and the right side of the figure presents model results from different emission scenarios into the future. Precipitation intensity in this figure basically represents total annual rainfall divided by the number of days during the course of the year when you have precipitation. Basically what it shows is that if global warming progresses over time you can expect to get more of our rain coming in a smaller number of storms. In other words, the frequency of extreme rain and snow storms will increase. The right side of the figure, the map, shows one possible scenario for

around the year 2090. Across most of the world in fact, precipitation and intensity is projected to increase. That is especially true for temperate parts of the northern hemisphere including the United States. There are two main reasons scientists believe that this fact will happen. First is because of the warmer temperatures caused by global warming, evaporation rates will increase. So water will evaporate faster from the land and from the surface of reservoirs and rivers and from the ocean. Second, warmer air can hold more water vapors – so from satellite measurements scientists have found that for every degree Celsius increase in average temperature in the air, the air can hold about seven percent more water. In looking at satellite data over the ocean over the past several decades scientists have identified an increase in the amount of water vapor, it's going up by about 1.2 percent per decade. They are concluding that fact is primarily due to human emissions of global warming pollution. These two factors combined to enable clouds to hold a greater amount of moisture which then leads to an increased likelihood of extreme participation.

Scientists are also predicting changes in overall precipitation patterns. So across much of the United States including North Carolina the predictions for a slight increase in the total amount of annual rain and snowfall. In other parts of the country including the Desert Southwest predictions are that it will become drier. In fact that this trend has already been documented in the scientific literature, a recent report by Environment Canada showed that the annual rainfall totals in temperate parts of the Northern Hemisphere have been increasing since the 1920's. Again this impacts their primarily assigning to human emissions of global warming pollution. Additionally the distribution of rainfall during the course of the year is likely to change. In general summers are likely to become drier and winters are likely to become a little wetter. On the other side of the coin of increased precipitation we have an increased likelihood for drought. So in between the more frequent extreme storms that we are expecting we are also expecting that global warming will cause extended periods of dry weather. So this is again a figure from the Intergovernmental Panel on Climate Change report from last year.

On the left hand figure it shows the number of dry days during the course of the year and the left side is historical information and on the right side is projections for what could happen in the future. Under one scenario of global warming which is a scenario for intense emissions called A2 up on the figure, the surface area of the earth that can be subject to severe drought conditions could increase to about 30 percent of the land mass of the globe. That is compared to about one percent of the globe today. This brings me to the research that we did. We looked to see if we could see changes in precipitation intensity using weather records from the (inaudible) United States. We studied the period from 1948 to 2006 and we looked at daily precipitation records from about 3,000 weather stations across the country. At each weather station we identified the largest storms that occurred and then again at each weather station we looked at trends overtime and the frequency of these storms to see if we could see if the largest storms were increasing in frequency. The upper left figure shows a distribution of

weather stations that we used across the country. On the lower right figure shows the thresholds that we used to define what an extreme storm was. Just to re-emphasize we looked at extreme weather relative to the local climate at each individual weather station that enabled us to do a comparison of areas all across the country, many of which get totally different amounts of rainfall during the course of the year. Here in North Carolina the threshold for an extreme storm in the driest part of the state was any storm that drops more than 1.9 inches of rainfall in 24 hours. Then in the wettest part of North Carolina an extreme storm was defined as any storm that dropped more than 4.1 inches of rainfall in 24 hours and then the rest of the state had thresholds that were varied in between those areas. So another way to describe the storms that we picked and to find it extreme was they were one year storms. So in a typical year between 1948 and 2006 any given location in North Carolina would expect to see one storm of this size or larger. What we found when we looked at this information that across the United States as a whole, the frequency of these extreme precipitation events have gone up by about 24 percent since 1948. We did a statistical analyses of our data to figure out the range of competence that we have in our results and according to that with 95 percent confidence we can say that the storms have increased in frequency by somewhere between 22 and 26 percent. This graph shows our results in a graphical form on the left axis is the average annual frequency of extreme rain storms and snow storms, the 's' axis is a time period. So the green dots represent across the continental United States as a whole the average annual frequency of extreme precipitation. If there were no change happening, what we would expect is to see a trend that looks a lot like this orange dashed line that goes through the middle with about one of these storms happening every year. However, the blue line represents the actual trend. In other words, what was an extreme storm back in the 1950's would not necessarily be characterized as an extreme storm today. The intensity of storms is increasing.

We also looked at this information under more local levels. In the south Atlantic area which includes states from Maryland south to Florida, we found that extreme storms had increased in frequency by about 15 percent. Here in the state of North Carolina we found that these extreme storms had increased in frequency by about 16 percent. This map shows the trends broken down at a more local level. The boundaries represent something called climate division which are boundaries that climate scientists have used since the 1950's to aggregate weather observations. As you can see in this figure some of the most dramatic increases in storm frequency occurred in the northeast where they saw about a 62 percent increase in extreme weather. In the mid Atlantic region the increases were around 41 percent; and in other areas where especially large changes occurred were in the Ohio region in Louisiana in New Mexico and in the Pacific Northwest. We determined whether the information for each one of these climate divisions was statistically significant which basically means can we say with 95 percent confidence that a change in extreme storm frequency has actually happened in these locations. What we found was that across about a little more than half of the area of the United States there was a statistically

significant increase in extreme storm frequency. In comparison there was only four percent of the United States that showed that statistically significant decline in extreme precipitation frequency so the trend is remarkably consistent across the entire country.

This is just a blown up part of that last figure looking at North Carolina and we found three climate divisions in this state that had a statistically significant increase in extreme precipitation frequency. Those are represented by the parts of North Carolina that have diagonal lines through them, so the southeastern north central and northwest parts of the state. Our results agree with what other researchers who have looked at this subject have found. In 2004 some climate scientists published a study that looked at this phenomenal worldwide and they found that storms are increasing in intensity in locations across the world from subtropical Brazil to Siberia. They have also found trends that are related including warmer weather, higher atmospheric water content, increased formation of storm clouds and increased thunderstorm activity over the United States. More over scientists at the National Climatic Data Center have concluded that most of the increase in storm intensity that we are seeing happened in the last three decades, making this a relatively recent phenomenon.

Other scientists have also looked at lengths between what's happening and human emissions of global warming pollution and they found a human finger print on a number of different trends that are occurring including increasing levels of carbon dioxide in the air, increasing global average temperature, changing temperature extremes, the widespread melting of snow and ice, raising sea level, altered wind pattern, increasing moisture content over the ocean, and increasing annual precipitation totals in temperate parts of the Northern Hemisphere. Evidence is also growing that the increased frequency of an extreme precipitation is also linked to human emissions of global warming pollution. In the last report of the Intergovernmental Panel on Climate Change they concluded that the trend that we've seen is more likely to not link to human global warming pollution and that in the future it is very likely that we will continue to see this trend increase. What are the implications to this trend in terms of the impacts that we can see here in North Carolina and in other parts of the country. Impacts can include an increased likelihood of flooding and related risk that water pollution from runoff and from sewage overflows, increased bread or water borne disease and the damage to agriculture. On the other side of that coin, we also can see an increase likelihood of drought. In the 20th century flooding was the natural disaster that caused more property damage and loss of life than any other natural disaster. I am sure that we all are familiar with serious floods that are happening in the recent times in North Carolina. For example, there was a storm in June of 2006 that struck the Atlantic coast dropping a significant amount of rain, it wasn't a hurricane but it did cause extensive flooding in communities from North Carolina up into New York. The property damage from that storm was around one billion dollars.

At the same time when you have heavy rainfall you can have increased runoff which carries the risk of water pollution. So after heavy rain water will runoff along fields or along streets and it can bring pollutants into the water making it less suitable for drinking and less able to support a diverse community of wild life. Many communities require developments to include storm water controls to prevent runoff from becoming a problem. Often times they set in thresholds say this community must be designed in order to manage the runoff from a one year storm event. However the design criteria for what a one year storm event is, if that was formulated ten or twenty years ago, it's no longer relevant because one year storms are becoming stronger and stronger over time. Communities are going to have to consider that when they are developing runoff control regulations. Other communities are going to have to revisit the controls that are already in place to take into account the fact that storms are likely to drop more rain in the future. At the same time heavy rainfall can increase the risk that the sewage system will overflow discharging raw or partially untreated sewage into the waterways which makes them less suitable for swimming or for drinking. The EPA estimates that around one trillion gallons of raw or partially treated sewage are discharged into waterways every year. This problem could become more serious because of the trend toward increasingly intense precipitation. This also carries a risk of increased spread of water borne disease. A study that looked at all of the water borne disease outbreaks that we tracked during the last half of the 20th century found that more than half of them were preceded by a major storm event.

Heavy rainfall can also cause agricultural damage, so after a heavy rain soils can become saturated which reduces the amount of oxygen in the soils and can either kill the plants out right or make them less resilient to tests. After the flooding that happened in Mississippi River Valley in 1993 there was about six to eight billion dollars of damage to the agricultural economy there and about 70 percent of that damage was due to super saturated soils as opposed to fields that were just flooded out right. A recent study by some folks at Columbia University looked at damage to the US corn crops from heavy rain storms between 1950 and 1990. They found that heavy rains caused about three billion dollars of damage each year to the US corn crop and they predicted because of the trend towards increasingly heavy rainfall damages to the US corn crop could double by 2030. At the same time the trend toward increasingly increased precipitation also brings an increased risk of drought. So as global warming progresses we will face increasingly extended periods of dry weather especially in the summer time which is expected to become drier. Then this situation will be aggregated by the fact that higher temperatures because of global warming will increase evaporation. Therefore water is more likely to evaporate out of the surface of reservoirs and out of rivers making water less available for people in North Carolina.

In conclusion global warming is already changing our weather pattern in physical ways. The climate models predict that the trend toward increasingly intense rain and snowfall will intensify in the future and at the same time the number of dry

days will likely increase making drought more likely. The severity of these trends depends on how much global warming pollution we emit. Again if you look at this figure from the latest Intergovernmental Panel on Climate Change report, it presents three different scenarios for human emissions for global warming pollution. The green line, A2 represents a scenario in which we reach about 1200 parts per millions carbon dioxide in the atmosphere by 2100. B1 (blue line) represents roughly 600 parts per million carbon dioxide in 2100 and the red line represents somewhere around 800 parts per million carbon dioxide. So as you can see the scenario that represents the greatest control of global warming pollution in this figure shows that the least increase in storm intensity. Some amount of change is inevitable given the pollution that we've already emitted to the atmosphere but the further we go in reducing emissions the more likely we are to avoid the worst impacts of this trend.

A few policy recommendations – I think we need to establish mandatory limits on global warming pollutions. Some of the things that the speaker earlier today from Maryland was talking about seem like they are on the right track. If we reach reductions of around 20 percent by 2020 and 80 percent by 2050, we will have a reasonable chance of avoiding some of the worst impacts of global warming. If we go further the benefits will increase. Also if policy makers decide to establish a cap and trade program to reduce global warming pollution emissions, 100 percent of the emission allowances or the permits to emit global warming pollution should be put up for public auction and the funds that were raised from that auction should be used for public benefit purposes including supporting an energy efficiency and renewable programs. If we do this it will help reduce the cost of meeting the global warming targets and it will make it more likely that we will succeed.

Finally, we need to adopt policies that will improve energy efficiency and increase the use of clean renewable energy. These are really important tools that we will need to deploy in order to meet the global warming targets that the science tells us is necessary. If you're interested in seeing the full report, you can find it on the Environment North Carolina website which is listed on the bottom of this flyer. And if you would like to contact me or my colleagues with Environment North Carolina please feel free to do so at any time and I'll be happy to answer any questions.

Representative Harrison: Thank you for that report. You might have said this, 1948 that's the year that you used for your research purposes and why did you chose that year?

Mr. Madsen: That was simply a decision based on the availability of data. In 1948 the federal agency that tracks weather information, that's the point in which they started to digitized a lot of their data back to 1948 and information before that would have been a little harder to get a hold of and it would have been covering less broad geography.

Mr. Garrou: Thank you very much for your presentation. Our last presentation will be from our own commission member Dr. Eggers who will talk to us about the Intergovernmental Panel on Climate Change most recent report.

Dr. Eggers: You are about to receive a forest worth of handouts I think. So if you will wait a moment I know that you're receiving several things and so one of them is the Summary for Policymakers (**Exhibit M**) of this IPCC report, another one is just a one pager that graph(**Exhibit N**), there are two documents from Southern Alliance for Clean Energy (**Exhibits O** and **P**). One of them is kind of a summary of the summary of this report and the other one is more recent scientific findings since this report came out in November. And I think possibly the final handout is Topic 6 (**Exhibit Q**) of the IPCC report which is actually just key findings and uncertainties and I think if you are going to read anything from the IPCC report that is a good place to start. It is very brief and really tells us in a nut shell what is going on.

I am going to go ahead and get started and thank everybody who, you know we separated the weak from the strong, apparently. Thanks to everybody who is still here.

The organization of this report which is not terribly long is as follows. There are six sections, the observed changes and the effects of those changes, causes of observed changes, impact projections, near and long term, and then we've got some adaptation and mitigation and then No. 6 which I mentioned that you're receiving which is robust findings and key uncertainties. Now I want you to know that the next three or four slides are boring but necessary and they will go quickly.

It is important to realize that the IPCC attaches very specific numerical values to their language and depending on what kind of approach they take to uncertainty those values are different. So under these three approaches, qualitative, more quantitative, expert judgment, statistical analyses, they have different language. Qualitatively analyzed things have very broad language like high or medium, etc. but more quantitative is as follows. So the confidences expressed as changes in ten so if you see something that says very high confidence, that means that there is a 90 percent chance or nine chances in ten. And that they had to agree that that was actually the confidence level they were dealing with, high confidence 80 percent chance, etc. Similarly expert judgment in statistical analyses, those confidence levels are, they use different words, which helps and so to say something is extremely likely means that it has greater than a 95 percent chance of happening according to the consensus of the IPCC scientists. So later in the report you will see these words used and I wanted to put these on my slides because you don't have them on any of the other handouts, they are actually in the introduction to the long report. As well the purpose of this, just to kind of reiterate what George Givens said is to actually get us familiar with this so that we can discuss the science and any questions people might have about this

specific science in more detail at the February meeting when the head of the IPCC will be addressing us at that time. So by way of introduction here we go.

No. 1 – Warming of the climate system is unequivocal as is now evident from observations of increases in global average air and ocean temperatures, wide spread melting of snow and ice and rising global average sea level. So unequivocal is a very powerful word for the scientific body to use. Some of the specific findings are that 11 of the 12 years between 1995 and 2006 are the warmest on record. We are seeing warming to a much greater extent at higher latitudes so for example, warming in the Artic is twice as high as the global average for warming. Land is warming faster than the oceans at this time and the rate of sea level rise is increasing. The sea level is rising and it is rising faster and faster and that is due both to thermal expansion and melting glaciers and ice. What kind of effects are we seeing? According to the IPCC observational evidence from all continents and most oceans showed that many natural systems are being affected by regional climate changes, particularly temperature increases. So system affects include in their report, they say there is very high confidence that terrestrial biological systems are strongly affected and you probably saw in the news for example, robins migrating farther north than ever before and indigence people not having any word in their native language or robins because they hadn't seen them earlier leaping etc. High confidence marine and fresh water biological systems are affected but medium confidence which corresponds to just over 50 percent chances for effects on human related systems, like agriculture and forestry. And that is because it takes a little bit longer for those secondary affects to show up in these systems and it is harder to measure.

What are the causes of these effects? According to the IPCC greenhouse gas emissions from human activities have increased since pre-industrial times 70 percent between 1970 and 2004 they increased. And those primarily came from three activities, the energy supply sector, the transportation sector and the industry sector. Emissions from agricultural buildings and forestry increased but at a slower rate. So graphically you can look at representation of emissions greenhouse gas concentrations from anthropogenic emissions according to this report, now when we first started meeting, Bill Schlesinger was going back two hundred thousand years in ice core data. Now the IPCC is saying quite definitively that we are seeing higher methane and carbon dioxide levels than we've seen in the past six hundred fifty thousand and that is the state of the science. And we are seeing higher nitrous dioxide than we've seen in many thousand years. The salmon in the white represent the GIGA tons of carbon equivalent per year emissions from CO_2. The salmon color is from human activities associated with fossil fuel use and other sources and then the white is from deforestation, decay and peat. We can look also at graphical representation in 2004 this was also in the report of the concentration of gases in the atmosphere and again the salmon and white corresponding to CO_2 and we've got methane and nitrous oxide, those are really kind of driving the train that so called 'F' gases are much smaller at this point and not exerting as much

climate forcing. The lower pie chart are the sectors that are responsible for emissions and when you look at that pie there are several sectors, energy supply and industry, agricultural and forestry though account for certainly the majority of it. So what are the effects of these types of emissions? The IPCC says there is very high, very high confidence that the net effective human activities since 1750 has been one of warming and that we expect for the next two decades a warming of about 1/3 °F per decade average global temperature, the net effect due to human activities since the pre-industrial era that these activities are resulting in radiative forcing of about 1.6 watts per square meter. So stay with me on this next slide, one of the more complex, this shows the relative contribution of various things in terms of the radiative forcing effect. And in this body you've heard a lot of information about conflicting theories on radiative forcing, so the IPCC most recently is saying this is what we think is the best state of the science. Everything on the right hand side of those zeros that's on the bottom is exerting a positive radiative forcing effect in other words, it's warming. Everything on the left is exerting a cooling effect, aerosol and some changes in reflectivity of the surface. So when we look at what is really driving the train, again we see carbon dioxide emissions, methane and ozone as well, stratospheric water vapor etc. Solar irradiance folks have talked about is like actually just sun spots and solar activity, this is perfectly natural. The IPCC says this is the radiative forcing solar irradiance it's not very high but the lower kind of dark red raising line is what is due to anthropogenic activity and that's about 1.6 watts per square meter as our current estimate. You may have seen this image before, kind of a way to think about this visually is as if there were 1.6 watt little Christmas light if you will, in every square meter of the surface of the planet would be one way to think about it. That was not in the IPCC report.

Climate change impacts – what's this doing? Assuming current climate change mitigation policies, this is key assuming current climate mitigation policies and related sustainable development practices, the IPCC basically said ok we need some models of how greenhouse gas emissions are going to grow over the next few decades. So there are six SERS models and you just heard about a few of them. I am going to present all six right now and show you some of what they are predicted to do. None of these six, by the way, remember this too, none of these six is reported to be more likely than any of the other six. These are just potential directions we can grow in given our current policy landscape. The A1 scenarios assume very rapid economic growth, a mid-century population peak, and rapid technology development. There are three A1 models - A1F1 is very fossil intensive that as you guess is probably going to have very high greenhouse emissions associated. A1T is non fossil intensive and A1B is balance across all sources. Then we've go three additional models, B1 same population assumption, more rapid transitional to a service and information based economy which would be less energy intensive. B2 has an intermediate population and economic growth estimate and emphasizes local solutions to sustainability, so again far less intensive in terms of energies for transportation with B2; and A2 high population growth rate, slow economic development and slow technological change, kind of a worst case that we could follow. What would these look like if

they were mapped out? And we've received this graph before on the climate commission but every time we get it, it's in black and white and then we can look at it on the screen in color and tell what things are associated with but not on the graph. So I just took the liberty of typing on the right hand side what the different scenarios are so that you can see where the lines are if you wanted to take a look at this after this meeting. You can see that A1T and B1 are graphs that are associated with lowest greenhouse gas emissions on the right hand side. And you might be thinking wait what was A1T again and what was B1? So A1T non fossil intensive, and B1 more rapid transition to service and information based economies. I'm saying this because I think this has implications for how we think about the policies we might want to put forward from this Commission and where is the bank for the bucks, what kinds of policies will be more likely to lead us on a different path. Also be aware that these are just emissions, they are not greenhouse gas concentrations in the atmosphere, so all of these scenarios would lead to continually increase in greenhouse gas concentrations because none of the emissions go below zero. They have to go net negative to actually degrease concentrations potentially, so keep that in mind.

Under the various scenarios this graph just shows you the best estimates according to the IPCC of temperature change. They are arranged by intensity so temperature change of anywhere from 3.24 °F (and I put in Fahrenheit) the report is in Celsius) so 7.2 °F. Sea level rise also on the right hand side, now these are the IPCC averages for sea level rise under these various scenarios and North Carolina would experience significantly more sea level rise because our coast is subsiding, so the numbers are much higher for us, but these are the numbers from the report.

You have one sheet of paper that has something on it that looks like this but I cut this up for the presentation, it's printed horizontally, I think, actually the lines with the red dots at the bottom. But I wanted to go through these specifically. So what you are looking at here on the slide at the top are the different scenarios and that red dot on the horizontal line indicate the best guess for warming under that scenario. You can kind of draw a line vertically from each of those scenarios to where they correspond vertically and effects on coast and health and food etc to read under A2, I guess we are going to expect to see definitely some problems with the coast, millions of people displaced etc. etc. You can look at it that way. Also on the bottom, I have a little legend here and you don't – so the dashed lines indicate that impacts continue with increasing temperatures so that more the temperature goes up the more we see that impact. The solid lines that you will see on later slides indicate the impacts are linked, so you might see one and then with more temperature increase you would see a different impact, but it is possibly linked. And the left hand side of where the text begins shows the temperature at which we start to see that impact.

Here in front of you with coasts you can see that for almost any increase in temperature we see increased damage from floods and storms and it is not until we have more than three degrees, right now we think that we receive about 30

percent of global coastal wetlands lost. Coasts are very important so let's talk about some impacts. You saw this picture today already from upstate – we are of course uniquely vulnerable in North Carolina because we have such low lying coastal plains and we are very vulnerable to storms as well. On the right hand side Hurricane Andrew the most expensive storm before Katrina in US history and then Hurricane Floyd which was certainly very, very expensive for this state, although a much lower category storm. In our coastal plains too when Hurricane Floyd sat on us and dumped all that water, there was a huge economic impact and it impacted our food system as well. With food some of the effects we expect to see are for almost any kind of warming is a complex localized effect because all kinds of different things will happen, some areas will get warmer, some colder, some dryer, some wetter. So we will see all kinds of different things happening but we will see a lot of things happening in different areas from any change in temperature. Then the rest of this focus is on serial productivity because these are just examples, these are not necessarily what the IPCC says are the most important or anything they just wanted to show some examples of warming and outcomes.

But other effects associated with food described in the IPCC report include the following: ships in areas suitable for various crops, maybe we can grow oranges here, plant diseases increasing though in many areas where it's warmer or wetter or both, plant pest increasing, animal diseases increases, and animal productivity changes. With warming we can see increased animal productivity in some places and we will see decreased animal productivity in other places, so depending on where they start, crop productivity also changing significantly.

Impacts on human health very important and also highly costly, I put this little picture of a mosquito down here because according to some scientist at the Center for Disease Control this may be one of the most expensive problems associated with global warming is the spread of areas suitable for malaria from the mosquitoes that transmit malaria. Increasing burden from malnutrition, diarrhea disease, cardio-respiratory and infectious disease for about half a degree warming will see increasing costs associated with that. Increasing morbidity and mortality from heat waves, floods, and droughts, morbidity is just how many people get sick, mortality is of course how many people die from something so for almost any increase in temperature we will see increases in those. In changes in distribution of some disease vectors, so definitely in the report says there is a likely increase in heat waves. I'll show you about disease vectors a little bit, we'll return to that in just a minute but first water which may really be the story of the 21st century. So the report for almost any increase in temperature again increased water availability in the moist tropics and high latitudes there is not decreasing water availability and increasing drought in mid latitudes and semi-arid low latitudes. They also predict hundreds of millions of people exposed to increasing water stress to cause civil unrest. In North Carolina we're already exposed to water stress, this is the US Drought Monitor, so I got this from January 8, 2008 and you can see that the darkest color that it looks to me is about half of the area of the state is what is called exceptional

drought and the red is extreme and then the remainder which is mostly orange is just severe. So that is where we are right now.

Stream flows, this is from Monday, January 14th, just two days ago, this is stream flows in North Carolina and you can see and it is no surprise that stream flows are very significantly low as well and I don't know about the rest of the state but there is a lot of talk about hay in western North Carolina and where are the people are going to get the hay over winter for their animals and hopefully a lot of folks have gotten that straightened out. So the report says there is a likely increase in areas affected by drought and a likely increase in heavy precipitation events, this is actually in Asheville, the ruminants of Hurricane Frances which came through and left 13 to 17 inches of rainfall on us in one day so the entrance to the Biltmore Estate and just (inaudible) system of the area that flooded met down there, very expensive for our community. Other outcomes the IPCC report says a very high confidence the systems related to snow, ice, frozen ground are affected and high confidence in increased runoff earlier spring melting which has a major implications for snow and glacier fed rivers and lakes, also warming of lakes. This is an actual river bed out in Washington State, early spring melting this year resulted in that river bed being virtually dry at this time. On the left hand side in the lower part of the screen, this is a salmon spawning stream. During the period when salmon would be spawning in it but it's a high stress spawning environment, very high stress spawning environment, it is completely dry, as well has a logic effect, increased runoff which you already saw so increased pollution loading, sedimentation, negative impacts on fisheries, negative impacts on coastal water quality and inter-coastal especially. The lower left hand corner, that is a reservoir that is used for hydropower generation and it's not doing a lot of hydropower generation in this picture because of course, it is very dry and up above that's a coal fired power plant, another problem that we're expecting to see is lots of cooling supplies for coal and nuclear power plants. So that is very important as we think about our energy future, we've had plants shut down in Tennessee and in France this year because of lots of cooling supplies, water cooling supplies, so that's a higher risk endeavor than we ever thought before at this point.

Impacts on ecosystems finally, increasing extinctions up to 30 percent, increasing coral bleaching, lower right hand you can see health corals and bleached corals. If we warm up a few degrees the IPCC says the terrestrial biosphere will turn into a net carbon source to warming over two degrees, turn into a net carbon source and really start positive feedback would force that pretty quickly. Species ranges also changing significantly, increasing wildfires etc, so this is a picture of our lovely mountains in western North Carolina we are predicting a lot more increasing wildfire impacts that expire in eastern Washington State, the tripod fire. There is a very likely decrease in cold days and nights predicted and frankly we all joke that whew global warming, bring it on you know especially on a day like today but remember with all those cold days and nights we have so much increase in disease vector for humans the ticks in the lower right hand corner and I could have filled up the page but that's kind of

gross for most people. But on the upper left hand corner you see wood boring insects and so major impacts potentially for forestry in North Carolina as we warm up and don't have as much bug die back, so things to think about.

In the report they talked about mitigation and adaptation at pretty great length, sections 4 and 5 are all about that. It is not a long report, I would recommend that you read it, but the report says more adaptation is required to reduce our vulnerability to climate change and a wide range of options exist now and are expected to exist under current technology trends by 2030 that for all sectors and the cost of mitigating CO_2 is averaged in the report and we know these are very big guesses economically. But $12 per ton of CO_2 for offsetting emissions or sequestration or what have you, the range in the report is negative $9 to $100 per ton with an average of 12.

So in a nutshell, I think this is the take home, the report says climate change is happening we're almost positive as positive as scientists ever get, humans are the primary cause, it will result in extensive and possibly catastrophic negative effects if no action is taken. And it is possible to significantly reduce the impacts on humans and non human systems and that the key actions required to reduce impacts are in the following areas. 1) To reduce fossil fuel consumption by expanding alternative energy, increasing generation and distribution efficiency, and low carbon energy sources and it does say nuclear in the IPCC report as part of that. To increase efficiency of cars, buildings, and industry are important. Reducing agriculture and waste emissions and increasing sequestration and finally adaptation and there is a (inaudible) on coastal adaptation in there as well. So all of these things will be required to reduce impacts on the human population and with that I'll just say do you have any questions?

(?): The terrestrial biosphere will tend toward a being a net carbon source at two degrees. Why is that?

Dr. Eggers: Increasing decomposition primarily, increasing rates of decompositions.

Dr. Riggs: Thank you for being so depressing here. How do we go forward, we're in our second year in this Climate Commission, this is an overwhelming undertaking, we heard the previous speaker talk a little bit about the economic cost to North Carolina if we do nothing in our coastal area and I would say from my experience that was incredibly conservative. But you've itemized another dozen, two dozen, three dozen issues here all of which will have an economic cost if we do nothing. This has been a very valuable experience sitting here learning about all of this, but I think it's time to get moving. I don't know how you get a Commission like this moving or I guess we've got some motion in the energy aspect of this but an awful lot of what you've mentioned hasn't even been on the table and I would like to make some kind of a motion that this Climate Commission burns some fuel and get some action going. We are all getting

older and things are changing and they are not going to wait for us. Thank you for your presentation.

Dr. Eggers: Thank you, I've heard this IPCC report called the We are All Going to Die Report and we are all going to die but let's not go down the tubes in such an unaware way as this. I think the most dangerous thing is business as usual and there is tremendous pressure for business as usual and it would be very nice if the room were entirely full for this and the last two presentations.

Mr. Garrou: Just to respond to you Dr. Riggs, we intend to start bringing forth some recommendations in March so I agree with you, we need to move.

Dr. Smith: In that spirit and building on the excellent presentations and then some of the things we heard earlier particularly the first thing that we heard about activities in Maryland earlier this morning, I don't whether these reference to whether we are the weak or the strong but those of us who are left here this late in the afternoon. I don't want to attempt to have the Commission decide anything at this moment but I do want to queue something up. It seems to me that based on the science we've heard over the course, the report this afternoon on the IPCC, the fact that we'll have distinguished guest at the Emerging Issues Forum coming up, gives us a fairly clear sense of what is a scientific goal for reductions going forward. We have also had discussions within this group about the various aggregate of policy activities that we can undertake and potential outcomes and North Carolina has taken some action over the past year. The Legislature with renewable standard and some other important provisions and those could be aggregated together to identify a suite of things that could give us a target. Where I am going is that as we discuss the concepts of a goal for reduction for the state, I think there is a goal that is based and grounded in science and as we heard from the Maryland example, may be aspirational and then there is a goal that I think it is very much within our grasp and then there is probably some gap between the two. And I guess what I wanted to queue up and I don't know if we can have a little discussion about it today, but for sure getting this in a more frank discussion going forward is, is it reasonable for us to think about having two goals one aspirational based in science and one directional based in an aggregate of policy recommendations that are achievable and can we set forth process to more fully debate that within the Commission. Because I think that is an important outcome of this stage of our work and I think it also gives us some directional targets that the fact that Dr. Riggs point so we can have some sort of benchmarks that we're accomplishing some things because there are some solid metrics being met and we have some benchmarks along the way that we can shoot for and this may then advise us going into the legislative session about what is possible. Again not seeking a formal decision at this point but wanted to queue that up and maybe think a little bit about how as a Commission we can go forward to address these opportunities.

Mr. Toben: I think this (inaudible) goal and I agree that that a discussion that could be had perhaps the March session given the agenda for February. But one

area that might be a rich vein to mind is to look at these other states that are undertaken a full study of mitigation options. Florida, California, New Jersey, New York some of the RGGI states already have enacted a number of the pieces of legislations that we are considering at least topically. I do think that those could be guides for us to look at, the CAPAG process has been a very useful process in terms of identifying large numbers of potential areas for us to explore in terms of draft legislation but it's a long distance between those recommendations and draft bills that might be considered in this upcoming session and even the 2009 session. I would encourage those of us that have particular areas of interest to really explore the other states' legislation related to those topics of interest and to bring those forward and as discussion points potentially in March or in the interim submit them to Mr. Givens for consideration and have the top seven or eight of those considered by the Commission and then discussed in the context of the sort of aggregate group and then also have the more aspirational goal as an agenda item for March.

Representative Harrison: Thank you for that presentation. I tried to get through the report and I didn't understand it nearly as well as your presentation today. I don't think I really got the context of the net radiative forcing the 1.6 watts per meter square. What's the context there if there weren't any anthropogenic impacts on global warming would be at zero or is there some naturals that can be said to solar but in terms of how we should look at 1.6 watts per meter square?

Dr. Eggers: I think from the scientific standpoint basically what that says is that as of now human activity are responsible for increasing the amount of energy on this planet and the amount we have increased it by is 1.6 watts per meter square. So it is kind of a definitive statement that human activities has increased the temperature of the planet and if we don't go off from business as usual we will continue to increase it just because of increase of greenhouse gas condensation in the atmosphere. Does that answer it?

Representative Harrison: Kind of but if we were attempting to mitigate it where would we be or if we didn't have any impact would it be at zero or 0.5 watts per meter square?

Dr. Eggers: Depends on the time scale of the analysis but basically it does depend on the science period so if we had prefect data over the entire history of the earth it would be at zero. And with that solar radius it shows that solar activity has warmed us up a little bit recently increasing solar activity but if we had the average over the history of the years it would average down to zero and the fact that there were no humans and no houses it would be zero. There would be things that would be making it cooler in certain periods of time and warmer doing certain periods of time if we just analyzed that year and that decade but over time it would be zero because it would be the average for all of those things over that time period.

Dr. Riggs: Just to add comment to that is a way to think about this is that there is a lot of stored solar energy buried in the earth that we're burning as fossil fuels and it is bringing more energy into the active system that's been stored there for hundreds of millions of years than would happen normally. This is your fossil fuel connection. Fossil fuel is stored solar energy and it has taken four hundred million years to produce our oil, we've burned it in a century.

Ms. Preyer: Thank you very much for breaking down something that is this important and was pretty formidable to most of us so I really appreciate that and based on you have experience coming as a scientist, knowing a lot about this report, you are also a commissioner and you hear the kind of concerns we are talking about of where we move forward and ideas. What would you recommend when we have this opportunity in February that we would ask the head of IPCC about and how can we take advantage of that time that would help move this commission?

Dr. Eggers: What would be optimal is that every single Commissioner be there and agreed that this is the best state of the science and we can move forward. The questions for Dr. Pachuari I think one of the most important questions for him would be: What do we know now that we didn't know in November? The answer is almost always the same. Well everything is going faster than we thought it was but here what we know now that we didn't know for the November report. Also what he thinks we need to do and personally I believe we need to go carbon negative. Eighty percent etc. etc. sounds (inaudible) but the outcome if we don't do or even if we do it is pretty bad and I think we really need to focus on sequestration. Now that is going to be a hard sell but that's the order. The sequestration is a big part of the solution and there was some proposed legislation you all got copies of today with regard to increasing soils and participating in carbon market and forestry and things like that. Great stuff to do. We can learn from other states but other states went through processes last year, two years ago when the science was not nearly as definitive as it is now. So if we follow the lead of several other states we will actually be behind the science at this point. So we probably need to also be looking at going much further in our emission reductions goal. In looking at this as a possibility Tim and I were talking about this on the side this time and last time, it would be great for North Carolina to put forward a green collar jobs initiative to really ramp up economic growth and ramp up training in the sectors where we need people trained. We need people trained who can go in and put in solar hot water systems, properly size them, properly install them, we need people who can go in and actually properly insulate homes. We need people trained to properly inspect buildings and we need to enforce our building inspection codes for new buildings. There are a lot of times new builders have spoken to inspectors who say the penetrations of the exterior wall where water and things come in and out are almost never properly sealed and air is just flying in and out so the code might be ok but the performance is terrible. So we fortunately because we haven't done much we've got tremendous opportunity. But for the state we can do a lot of job creation and we also need our community colleges and universities

to be doing different kinds of training with students so that when our engineering students graduate, when our architects graduate and even when our accountants graduate, they understand the relevance of these things and how to think about them and how to be trained actually contribute to an economic shift for the state. Otherwise, we are just talking about driving off a cliff at 5 mph.

Mr. Garrou: Thank you Dr. Eggers that was a great presentation, very helpful. Now back to the more generalized discussion.

Mr. Stephenson: Thank you Mr. Chairman, we saw several presentations on adaptation today and I think it is pretty clear that the changes that we will be facing in this state are significant from both an economic and ecological prospective. One of the recommendations that the Commission approved back in the spring of last year was to consider developing a blue ribbon commission or committee on adaptation to look at the various aspects of it both the coast and all the state. Now that the commission appears to be continuing in 2009 I think the question is how do we approach that recommendation, how do we deal with the issue of adaptation? It could be that a CAPAG process on adaptation may be appropriate to advise and provide recommendations to the commission but I just like to not lose that as we go into March and suggest that we revisit that recommendation and find a way to take action.

Ms. Tompkins: Thank you and thank you for your great clarifying presentation. I would like to ask how could something like a green collar job initiative or manifest be done in relation to this Commission? I think that it is time that we as the Paul Reveres of climate change for this state get some information out to the citizens of North Carolina, maybe doing that initiative would be one way to do that. I think the citizens of the state would like to see some time line especially if we've got another year to be working on this. So that really is a question to the chairs about how we might do that and we could continue this with emails, but maybe a brief answer now? Thank you.

Mr. Garrou: On the green education thing, there may be things that we recommend that will not require legislation. I can't think of what they are. I think most or all of our recommendations will involve recommendations to the Legislature. So we will be drafting legislation that we will present to the Legislature and ask them to pass and that will be included.

Ms. Tompkins: Could something like a green jobs state wide manifest, whatever you want to call it.

Mr. Garrou: If it is going to take money, then the General Assembly will have to appropriate it and we will have to go through the General Assembly.

Ms. Tompkins: If any of the commissioners have any creative ideas on that I would appreciate them.

Mr. Garrou: I agree with you about it is time for us to begin to educate the public about what we are going to be recommending.

Dr. Eggers: In what way would the Commission engage in education? Would this body put together a one page state of the science or state of the commission opinion and do that as a press release or how would that work?

Mr. Garrou: My thought and this is just my own thought is in connection with whatever recommendations we make of the Legislature we would want to justify those recommendations and we would want to justify them to a wider audience than simply the General Assembly. That is my own thought.

Mr. Urlaub: Thank you. Along the lines of this discussion that I know has been buzzing for a while now about green collar jobs, we've had a lot of debate in our nonprofit organization about the value of focusing on job training up front. You can train a lot of people to do something but if you still have a regulatory in policy environment that precludes companies from employing people that do those things, they are not going to find jobs at least not here. We have Appalachian State University's appropriate technology program where a lot of those students are leaving our state to go work in other states because the opportunities are not nearly as competitive here in our state. That continues to be a red flag for our organization as we access the priority order here of what we can do to go about in a simple fashion of creating a green economy for our state. We are seeing indicators that we may very well have very fundamental barriers distracting or not attracting industry here and not motivating existing industry to transition into for example the new energy economy and green jobs sectors. An evaluation of that or at least a discussion of that, like what are those remaining barriers, I know that is a really tough, it's a conflict laden and often politicized discussion and I would just hate to see us kind of opt for the easier take incentive options to spend money on a training program option without that precursor discussion.

Mr. Garrou: Good point thank you. This has been a long session but I think it has been a good one and appreciate everybody here coming and we look forward to seeing you at the Emerging Issues Forum. Thank you very much. We are adjourned.

Respectfully submitted,

Representative Pricey Harrison, Co-Chair

Thelma Utley, Commission Clerk

Mr. John Garrou, Co-Chair, Presiding

APPENDIX

Exhibit A	Visitor Registration Sheet
Exhibit B	Emerging Issues Forum Invitation and Website Information
Exhibit C	Agenda
Exhibit D	Photocopy of NC State Alumni Magazine Cover and Information on Dr. Rajendra K. Pachauri
Exhibit E	A Legislative Proposal to Prepare North Carolina's Agriculture and Forestry Sectors for Emerging Carbon Marketplace
Exhibit F	Maryland's Climate Action Plan Establishing Goals by Tad Aburn
Exhibit G	Press Releases – N. C. Energy Policy Model 'Not Credible' and Serious Problems 'Plague' NC Climate Change Report – Senator Pittenger
Exhibit H	Background for a Process on Adaptation to Climate Change in North Carolina – Climate Action Plan Advisory Group
Exhibit I	Impacts of Global Warming on North Carolina's Coastal Economy (2) – Chris Dumas
Exhibit J	Planned Work Products: "North Carolina Coastal Hazards-Economic Implications of Severe Storms and Sea-Level Rise" – Steve Culver
Exhibit K	Environmental Defense News Release and Florida and Climate Change – The Costs of Inaction – Dr. Frank Ackerman
Exhibit L	When It Rains, It Pours – Travis Madsen
Exhibit M	Intergovernmental Panel on Climate Change Fourth Assessment Report – Dr. Eggers
Exhibit N	Examples of Impacts Associated With Global Average Temperature Change – Dr. Eggers
Exhibit O	IPCC Fourth Assessment Report: Summary and Key Findings – Dr. Eggers
Exhibit P	Southern Alliance for Clean Energy – Dr. Eggers
Exhibit Q	Topic 6 – Robust Findings, Key Uncertainties – Dr. Eggers

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VISITOR REGISTRATION SHEET

Legislative Commission on Global Climate Change — 01/16/08

Name of Committee — **Date**

VISITORS: PLEASE SIGN IN BELOW AND RETURN TO COMMITTEE CLERK

NAME	FIRM OR AGENCY AND ADDRESS
Chung	NCGA Bill Drafting
Christa Wagner	NC Sierra Club
Elizabeth Ouzts	Environment North Carolina
Erin Kinney	NC Conservation Network
Leslie Kleczek	Nicholas Institute, Duke
John Noor	University of North Carolina General Administration
Peter Allen	Moore + Van Allen
Jim Southerland	NC DENR / DAQ
Heather Hawkins	NC DENR / DAQ
Kim Garnett	Public Staff - Electric Division
DONNIE REDMOND	DENR/ DAQ

VISITOR REGISTRATION SHEET

Legislative Commission on Global Climate Change — 01/16/08

Name of Committee — **Date**

VISITORS: PLEASE SIGN IN BELOW AND RETURN TO COMMITTEE CLERK

NAME	FIRM OR AGENCY AND ADDRESS
KRIS CORACINI	ENVIRONMENTAL DEFENCE
DENISE CHOY	"
Jesse O'Neal	Environmental Science & Policy, Inc, Raleigh
Angie Whitener	NC Park Council
Dan Crawford	Electricities of NC
Chris Dumas	UNC-Wilmington
TAD ABURN	MD. Dept of the Environ
Ken Colburn	Center for Climate Strategies
Bill Dougherty	Stockholm ENVIRONMENT INSTITUTE - US CENTER
Tom Pedersen	CCS
Jim Rutt	Charlotte Observer

VISITOR REGISTRATION SHEET

Legislative Commission on Global Climate Change — 01/16/08

Name of Committee — **Date**

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NAME	FIRM OR AGENCY AND ADDRESS
Becki Gray	John Locke Foundation
Jon Carr	Jordan Price Law Firm
Tom Cors	TNC
PATRICK BUFFKIN	Nelson Mullins
John McKay	GOV OFFICE
Amy McConkey	Smith Anderson
JOHN SHAW	SBEP
LISA RIEGEL	NWTF
Bob FORD	NC Poultry FED
Yallana Boston	Speaker Hackney
JIM HAVEN	GLOBAL WARMING INITIATIVES

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Legislative Commission on Global Climate Change — 01/16/08

Name of Committee — **Date**

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NAME	FIRM OR AGENCY AND ADDRESS
Libby Smith	Commerce
[illegible]	NIEHS/NIH/Duke
Valerie McMillan	independent consultant, 219 Forest Rd Raleigh NC 27605
Lindsay Wilkes	Nature Conservancy
Tom Cors	TNC
David Knight	TNC
Maximilian Merrill	NCDA+CS
Bill Crowell	Albemarle-Pamlico Natl. Estuary Program
Doug Howey	NC Petroleum & Convenience Marketers
Ulla Reeves	Southern Alliance for Clean Energy
[illegible]	John Locke Foundation

VISITOR REGISTRATION SHEET

Legislative Commission on Global Climate Change 01/16/08

Name of Committee **Date**

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NAME	FIRM OR AGENCY AND ADDRESS
Leanne Mabe	DENR
Lu-Ann C. Peryman	ITW
Thomas Moore	Edmisten, Webb
John Goodman	NC Chamber
Wendy Kelly	HMW
David Barnes	Pepper Hamilton
Bruce Thompson	Parker Poe

EMERGING ISSUES WEBSITE REGISTRATION

1. The dates of the Forum are not listed on the invitations. The Forum is scheduled for 11 February through 12 February 2008.

2. Registration is limited and will probably close this week. Please register for the Forum this week. **Register at www.emergingissues.org**

3. Click on "Register Now for the Forum" located in the upper right hand side of the page.

4. Enter your first and last name, email address, and select "Non profit, Government, Higher Education."

5. Click the "Next" button.

6. Continue to enter your personal information, item selections, and payment.

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Legislative Commission on Global Climate Change

State Legislative Building Raleigh, North Carolina

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AGENDA

10:00 a.m. Wednesday 16 January 2008
Room 643 Legislative Office Building

1. Call to order
   John. L. W. Garrou

2. Introductory remarks by Cochairs
   John. L. W. Garrou
   Representative Pricey Harrison

3. Report to the Commission and explanation of agenda items
   George F. Givens, Commission Counsel

4. Discussion of strategies to mitigate and adapt to global climate change
   Emissions reduction goals and standards in the state of Maryland
   George S. "Tad" Aburn Jr., Director
   Air and Radiation Management Administration, Maryland Department of the Environment

   Adaptation to the effects of climate change in the state of Maryland
   Kenneth A. Colburn, Senior Consultant
   Center for Climate Strategies

   Bill Dougherty, Senior Scientist
   Center for Climate Strategies

   Report on progress in consolidation of the recommendations of the Climate Action Plan Advisory Group (CAPAG)
   Thomas D. Peterson, President and CEO
   Center for Climate Strategies

Presentation of the report: "Measuring the Impacts of Climate Change on North Carolina Coastal Resources" prepared for the National Commission on Energy Policy
Christopher F. Dumas, Associate Professor
University of North Carolina at Wilmington

5. Presentation of the report: "When it Rains, it Pours: Global Warming and the Rising Frequency of Extreme Precipitation in the United States" prepared by Environment America
Travis Madsen, Policy Analyst
Frontier Group, Environment North Carolina

6. Preparation for the 11 February 2008 meeting of the Commission: Summary of the "Synthesis Report from Climate Change 2007" prepared by the Intergovernmental Panel on Climate Change (IPCC)
Dolores M. "Dee" Eggers, Commission member and Associate Professor
Department of Environmental Studies, University of North Carolina at Asheville

7. Commission discussion and announcements

8. Adjourn

SCHEDULE OF FUTURE MEETINGS:

The Cochairs and Counsel have established the following schedule of meetings of the Legislative Commission on Global Climate Change for the 2007-2008 Legislative Interim. Except as noted, all meetings are scheduled for 10:00 a.m. This schedule is subject to revision.

Commission Meeting	**Location**
Monday 11 February 2008* – Emerging Issues Forum	McKimmon Center, NCSU
* Business Meeting 2:30 p.m. to 3:45 p.m.	Room 2, McKimmon Center, NCSU
Tuesday 12 February 2008 – Emerging Issues Forum	McKimmon Center, NCSU
Wednesday 5 March 2008	643 Legislative Office Building
April meeting to be rescheduled	
Wednesday 7 May 2008	544 Legislative Office Building

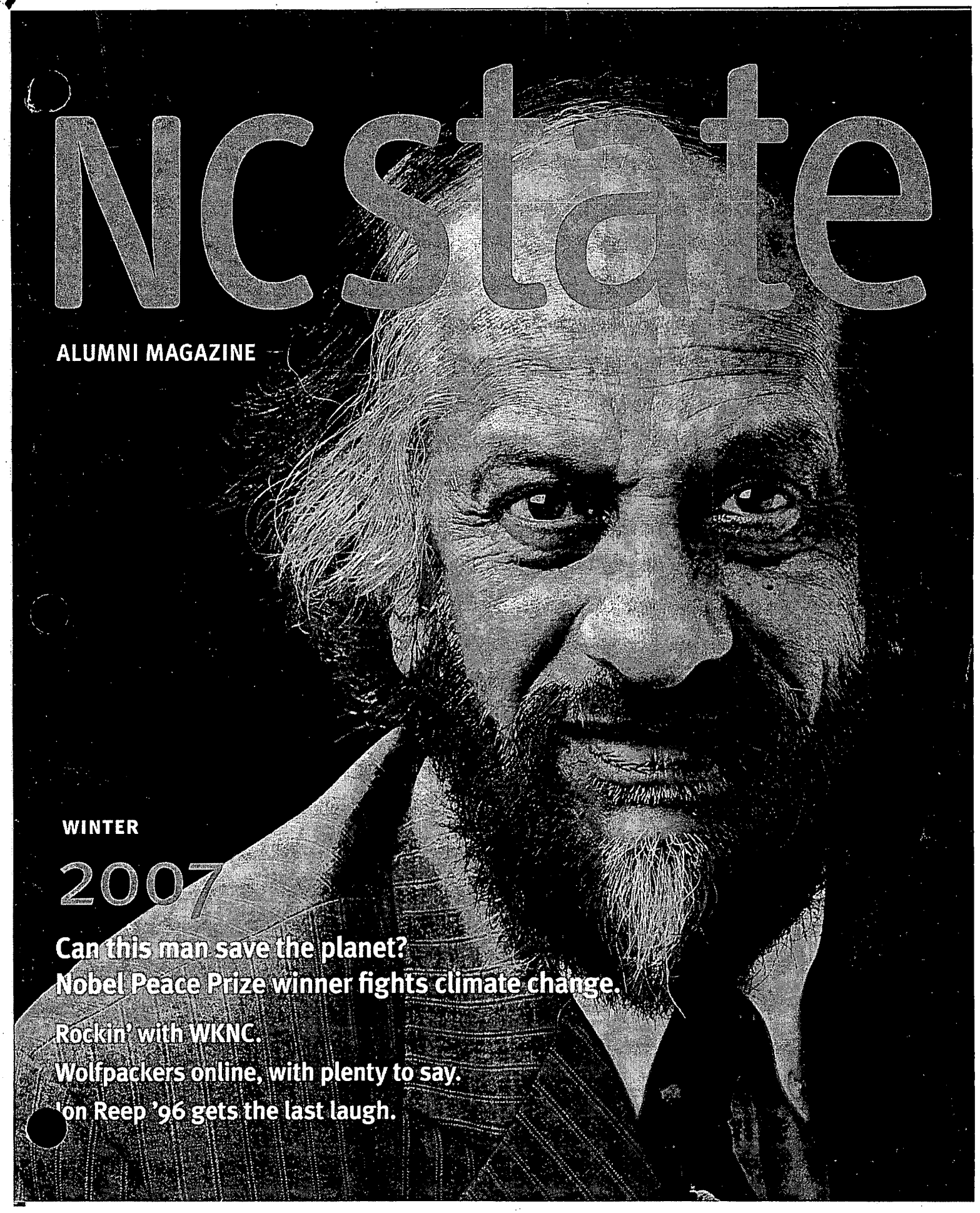
COMMISSION WEBSITE:

In order to provide public access to the materials distributed at the meetings of the Commission and to other documents related to the Commission, a website has been developed for the Commission. The website can be viewed online at the following address:

http://www.ncleg.net/gascripts/Committees/Committees.asp?sAction=ViewCommittee&sActionDetails=Non-Standing_6268

ADDITIONAL INFORMATION:

Persons having questions about the Commission meeting or other matters related to the Commission may contact Commission Counsel or other Commission staff at (919) 733-2578.



NCstate

ALUMNI MAGAZINE

WINTER

2007

Can this man save the planet?
Nobel Peace Prize winner fights climate change.

Rockin' with WKNC.

Wolfpackers online, with plenty to say.

'on Reep '96 gets the last laugh.

EYES ON THE PRIZE

Rajendra K. Pachauri '72 MS, '74 PHD chairs the U.N. committee that shared the 2007 Nobel Peace Prize with Al Gore for its work on climate change. He hopes the award will inspire action that will aid the planet.

INTERVIEW BY REBECCA MORPHIS

Photograph by Lisa Nipp

A good international calling plan is a must for Rajendra K. Pachauri '72 MS, '74 PHD. Today, he answers his cell phone from a hotel room in Washington, D.C. The day before, he flew in from Tokyo, Japan, and later this afternoon, he'll head home, to New Delhi, India, via Vienna, Austria.

Pachauri's time zone-bending schedule has only gotten more hectic since he accepted in October the 2007 Nobel Peace Prize on behalf of the Intergovernmental Panel on Climate Change (IPCC), the United Nations committee he has chaired since 2002. The Norwegian Nobel Committee awarded the prize jointly to former Vice President Al Gore and the IPCC "for their efforts to build up and disseminate greater knowledge about man-made climate change, and to lay the foundations for the measures that are needed to counteract such change."

Pachauri, 67, has been instrumental in that effort. Comprising 3,000 atmospheric scientists, oceanographers, ice specialists, economists and other experts, the IPCC is the world's top scientific authority on global warming and its impact. As the first elected chair of the IPCC (the position was previously appointed), Pachauri oversees the meticulous—and politically contentious—process of synthesizing all available climate-change research into weighty reports that sum up the scope of what's happening to the planet and what it means for the future. About 800 authors from 130 countries contributed to the committee's fourth assessment report, *Climate Change 2007*. More than 620 experts and government representatives reviewed the report's four volumes—the last was released in November—prior to publication.

Pachauri, who earned doctorates in both engineering and economics from NC State, also heads New Delhi-based The Energy and Resources Institute (TERI). He first became interested in energy markets as a graduate student, when he wrote his master's thesis and dissertation on forecasting electrical energy demand. The father of three worked briefly as an economics professor at NC State before joining the faculty of a university in India. In 1981, he became TERI's director, and by the late 1980s, his research had led him to examine the intersection between energy and the environment. He became convinced of the dangers of climate change. The Nobel Prize will give the issue an even higher profile, he says, as well as give a gratifying boost to the scientists who have devoted their careers to studying it.

Pachauri will return to NC State in February to speak at the Emerging Issues Forum, which will focus on energy. Between now and then, he'll probably have crossed the Atlantic and Pacific oceans multiple times. His passion for what he is doing, he says, keeps him going.

What convinced you that climate change was something to be taken seriously?

The scientific reality was so compelling. You know, climate change is something that had been predicted more than a century ago. There was a Nobel Prize winner who actually wrote a paper in 1896—[Svante] Arrhenius. He was a Swedish scientist, and he predicted the fact that if human society uses more and more fossil fuels, we'll produce greater quantities of carbon dioxide, and that's going to lead to global warming. So it's not as though this phenomenon was unknown. It's been known for a long time.

In recent years there's just so much scientific evidence. The fourth assessment report of the IPCC clearly brings out the fact that it's not merely on the basis of models or hypotheses. It's on the basis of observed readings and data that we can clearly analyze what's happening to the Earth's climate. And, of course, you can't base scientific analysis on anecdotal evidence, but if you want to look around, there's plenty of that, too. There's really been an explosion of scientific material, so I think that the doubts that anyone had earlier should really be put to rest.

What are your greatest hopes and fears related to the environment and global warming?

My biggest hope is that we're turning the tide now, and you will probably see action on the part of decision makers, society lead-

ers and the average person on the street. My biggest fear is that we might delay action, and you're probably going to see impacts that are going to be quite ugly. We really should move ahead with a sense of urgency, and my fear is that we may not do that. There are a lot of vested interests. There's procrastination on these issues, longer than is required. All of that can be negative.

Has the politicization of climate change made it difficult to act?
Anything that's going to affect the future of humanity and the activities that we are engaged in will be politicized. Politics is very much a part of it. What you really need to do is make sure that you have informed decision-making. People must be able to use their logic; they must use their knowledge. I believe very strongly that information dissemination is totally essential in this case. I've believed this all along, and to some extent that belief has been vindicated by the Nobel Prize. The Nobel Prize has come not merely for producing the science, but also for getting it out to the people. I can tell you this time around the IPCC has really made a major effort to see that the results are disseminated on a large scale.

Writing the IPCC reports is quite a process. Not only do the hundreds of scientists involved have to reach a consensus, but so do government representatives from more than 100 countries, including the U.S. Can you tell me about that?
Yes, you should come to one of our meetings. You'd be surprised that reports get accepted and approved at all. There's really nothing that can be cited as a parallel to the IPCC process. The best experts and scientists from all over the world contribute their time and talent to producing these reports. The fact that governments go through them line by line and approve of the summary for policymakers makes them stakeholders—gives them ownership of what is produced—and that certainly adds to the strength of our reports. They're not just academic reports produced by scientists, but they are something that governments have approved of, and agree with, and that really adds a huge amount of value to what we produce.

What challenges do you face during this process, and how do you reach consensus when working with so many stakeholders?
I think that everyone wants to see the process succeed. There's nobody out to disrupt anything, and where you find people have differences of opinion, you set up what is known as a contact group. People go and sit outside the conference room and try to resolve their differences and come up with a compromise. More than anything else, when you chair a session of that kind, you've got to create a harmonious atmosphere. You don't allow confrontations to get out of hand. You don't yourself confront people. You give everyone a patient hearing and treat them with respect, as they should be. It's really a combination of art and science. Ultimately, you've also got to respect the authors. They are the ones who really worked hard. You can't toss out anything they've done through the window unless there are valid reasons—and they have to accept the reasons. It's a pretty complex process, but the good thing is it works in the end.

How does all of this collaboration affect the final project? Do the conclusions ever end up being watered down?
The whole thing is done very transparently, so it's not as though any single government holds sway. There's a discussion of everything. There are pros and cons. Therefore, people feel very responsible when they take up a position or put across a point of view. What you get is essentially a balanced result.

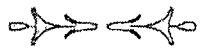
I hear you work very long days—17 hours?
There are times when you have to do even more. In Brussels, we had the final night when we kept working through the night, and finally the report was approved well past 10 o'clock the following morning. So it was really more than a 24-hour effort. There are times when you have to do that. Because apart from managing the TERI institute, I have IPCC responsibilities, I really have no choice but to work every day of my life and work long hours. There's a lot of travel that's also involved, and physically that can also be pretty taxing.

How do you sustain a schedule like that?
It's just the adrenalin that keeps going through your system. And I think that you have to try and eat right, and you need to see that your body gets enough exercise—remain active mentally and physically. I think it just keeps you going. I suppose I'm lucky to have a constitution that can stand this kind of stress without breaking down—so far at least.

You grew up in the Himalayas, an area that's likely to be affected by climate change and melting glaciers. And today you live and work in New Delhi, which has some significant pollution problems. How has living in India shaped your view of climate change and the solutions for climate change?
Happily, in Delhi there's a lot that's happened. The air is much cleaner now because of federal regulations that were imposed by the Supreme Court of India. (Measures implemented since 2001 include shifting buses from diesel and gasoline to compressed natural gas.) If one takes a concerted approach, there's no reason why you can't solve these problems—and solve them in a short period of time. And if you can solve them at the local level, you can certainly solve them at the global level, as well. The cost of action is really not high at all. It's so small compared to what you're going to be able to avoid in terms of impact and damage that it is totally senseless and illogical not to implement those actions.

Through the scientific reports it has issued over the past two decades, the IPCC has created an ever-broader informed consensus about the connection between human activities and global warming. Thousands of scientists and officials from over one hundred countries have collaborated to achieve greater certainty as to the scale of the warming. Whereas in the 1980s global warming seemed to be merely an interesting hypothesis, the 1990s produced firmer evidence in its support. In the last few years, the connections have become even clearer and the consequences still more apparent.

—FROM THE LETTER ISSUED BY THE NOBEL COMMITTEE AWARDING THE 2007 NOBEL PEACE PRIZE JOINTLY TO THE IPCC AND FORMER VICE PRESIDENT AL GORE



What are some of the best solutions for climate change?
Price carbon in such a way that it provides an appropriate signal to the market. If there was a proper price on carbon, that would induce companies to invest in low-carbon technologies. It would induce consumers to move away from carbon-based fossil fuels and look for options that are low in carbon intensity. That would include things like public transport. It would include more efficient cars. And so on—using compact fluorescent lamps, more efficient lighting devices, lowering your thermostats.

One of the things that I think is essential is to change behavior patterns, as well. Human society has to start taking some steps to change its patterns of consumption and behavior. All of that will happen, firstly, through awareness and knowledge and, secondly, as a result of prices that clearly signal the fact that we are imposing a huge externality on society as a whole and all of the ecosystems of the Earth.

What we've also assessed is that you really don't have to wait for fancy technologies to develop. The technologies that you need for effective mitigation are all there. It's a question of developing a policy framework and coming up with regulations, with pricing systems and so on, which will make things better.

What countries do you think are taking the proper steps to combat climate change?
They all have a long way to go, but there are some that are doing more than others. In Europe there's a much higher level of awareness and resolve to get things done. Germany has done a lot. They are moving to renewable energy in a big way. Japan has been very good in that regard. France, of course, for totally different reasons [shifting to nuclear energy and modernizing its rail system]. That's made a substantial difference. Each one of them is doing things that are worthy of emulation.

What advice do you have for those interested in making a difference and a positive impact on the world?
I've always felt a restlessness about doing things that will hopefully make a difference to society. I think that if you have that burning desire, you'll always find a way of doing things that are of value. There are times when you are frustrated when things don't work the way you want. But you have to keep at it. Perseverance is absolutely critical. You just can't give up in the middle of a mission you've taken on. If you're convinced of the value of the mission, you've just got to see it through—and you will be able to see it through.

You've written—or contributed chapters to—more than 60 books, including a collection of poetry called *Moods and Musings* that you wrote with your daughter. Why is a scientist writing poetry?
Well, I've been writing poems since I was 8 years old. That's something I've always enjoyed doing and will continue to do. It's just something which gives you a different dimension. I mean, I became a researcher much later in life. I always thought I would be an author: I would be writing verse, and I would be writing fiction. I just got sidelined, and I strayed into other areas.

Rebecca Morphis is managing editor of *NC State* magazine.

DRAFT

A Legislative Proposal to Prepare North Carolina's Agriculture and Forestry Sectors for Emerging Carbon Marketplace

Background

The U.S. Congress is poised to enact national climate and energy policy that caps and requires reductions in emissions of greenhouse gases or offsets of greenhouse gas emissions. Under the terms of the current proposal in the U.S. Senate, this will create a $20 billion annual market for domestic offsets. NC is well positioned to take advantage of this economic and environmental opportunity. Through education, guidance and support, the state can enable its farm and forest landowners to capitalize on the emerging economic opportunity.

A New Opportunity

Carbon offset projects involve activities implemented by farmers and landowners to avoid greenhouse gas emissions or sequester greenhouse gases. If done properly, these actions can produce high-quality, verifiable greenhouse gas reductions or credits that can be sold to a variety of entities in the emerging carbon market. High quality carbon offset projects bring higher financial returns to landowners, while also ensuring that the environmental benefits of the projects are secured. Educating landowners about the carbon marketplace can ensure they understand the opportunity and can fairly negotiate a fair deal.

North Carolina is fertile ground for the emerging carbon offset market. The state has caught the attention of many investors, who are lining up substantial capital to create carbon offset projects in North Carolina. One multi-billion dollar investor represented to several commissioners that North Carolina was one of only three states in which they were seeking to invest, based on the positive environment already created by recent legislation. Still, those recent bills are only a first step; whether the state becomes a national leader in carbon offset projects will depend on actions taken now to develop clear guidance on offset projects.

The state's actions to spur carbon offset projects will help lay the foundation for some of the recommendations from the CAPAG on agricultural and forestry practices to reduce greenhouse gas emissions. Essentially, carbon offset projects serve as one of the major financial mechanisms by which these activities can be put on the ground. With minimal investment from the state, North Carolina can create a carbon offset friendly climate and get the incentives right to recruit new industries.

Taking Action

While the opportunity of economically viable carbon offset projects grows, most investors and landowners are waiting for a clear signal of how to proceed. In order to

move ahead, the Legislative Commission on Global Climate Change should recommend and the 2008 General Assembly should:
(1) Enhance efforts to educate landowners who are eligible to engage in carbon offset projects;
(2) Authorize the creation of clear and uniform guidance for carbon offset projects in North Carolina; and
(3) Create incentives and expand business opportunity for carbon offset projects.

Action Item 1: Educate farmers and landowners about the emerging carbon offset market.
As project developers arrive in NC, our landowners are increasingly being approached by companies they don't know and being offered financial returns for products they've never considered. With technical and educational assistance, as only the state can provide, farmers and other landowners can be prepared to seize the opportunity.

- Direct the Cooperative Extension Service, DSWC, local districts, DFR, and Rural Economic Development Center to educate farmers and landowners on the opportunities to participate in the emerging market for carbon credits and appropriate funds for the educational programs.
- Fund one or more Cooperative Extension positions to work directly with landowners and project developers.

Action Item 2: Establish standards for effective and financially viable carbon offset project.
Carbon offset projects must achieve real, meaningful carbon reductions. Standards are needed so that investors and landowners understand exactly what they are getting and what is required of them. The monetary value of offsets depends on whether they meet high quality standards and create a verifiable net reduction of greenhouse gases in the atmosphere.

- Reduce uncertainty in the marketplace by authorizing the Environmental Management Commission, after consultation with the Soil and Water Conservation Commission and others, to develop and adopt standards for agriculture and forestry emission reductions and offsets that achieve net environmental benefits. The standards created in the recent Duke University Press publication "Harnessing Farms and Forests in a Low-Carbon Economy" – commonly referred to as the "Duke standard" – could be a starting point.
- Clarify that farmers and landowners retain the rights to carbon credits when they receive state conservation funding for water quality, wildlife, nitrogen reduction or development rights, unless the program explicitly purchases those carbon credits.
- Clarify that GS 62-133.7(i)(3) (SL 2007-397/SB 3, Renewable Energy Standard Act) applies to renewable energy credits but not carbon credits. Carbon and renewable energy are separate commodities.
- Create strong State Climate Registry to 1) track agriculture and forestry emission reductions and offsets and 2) provide voluntary registration of carbon offset projects.

Action Item 3: Create incentives to expand business opportunity for carbon offset projects.

To date, business interests related to carbon offset projects have 'stumbled' into North Carolina. As the state has done with other business opportunities, the state should establish a coordinated recruitment and incentive program to help landowners jumpstart high quality carbon projects. Carbon prices are increasing. But some prototype carbon offset projects have high, upfront transaction costs and delayed income, limiting the financial returns. Lowering measurement, verification and other transaction costs could help more landowners participate in this emerging market.

- Increase private investment by directing Departments of Agriculture, Commerce and DENR to work with key commodity groups, including swine producers, dairy producers, and forest landowners and carbon aggregators to develop major projects.
- Develop a strategy to recruit & grow the carbon offset industry much like those developed for the biotech, biofuels, and other industries.
- Lower transaction costs for both landowners and carbon developers by authorizing the Department of Environment & Natural Resources (DENR), including the Division of Soil & Water Conservation (DSWC), local soil & water conservation districts, and the Division of Forest Resources (DFR), to provide measurement and verification services to farmers and landowners.
- Reduce the costs of environmentally superior hog waste management processes that capture methane and address other pollution problems and attract additional private investment in improving hog waste management by appropriating $5,000,000 to the Division of Soil & Water Conservation's NC Lagoon Conversion Cost Share Program.
- Maintain/Increase funding for state agriculture and forestry cost-share programs such as CWMTF, ADFPTF and the NC Forest Development Program.

MARYLAND

Department of the Environment

Maryland's Climate Action Plan
Establishing Goals



Tad Aburn, Air Director, MDE

January 16, 2008

MDE

MDE Climate Change Initiatives in MD

- Governor O'Malley's Executive Order on Climate Change
- The Healthy Air Act (2006) and RGGI (the Regional Greenhouse Gas Initiative)
- Clean Cars Act of 2007
- EmPOWER Maryland Initiative





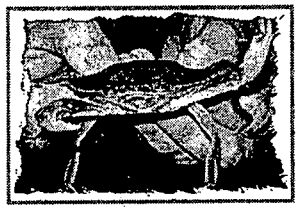
Stan Allen, VIMS

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Maryland Executive Order

- Establishes the Maryland Climate Change Commission
  - 15 Cabinet Secretaries and 6 representatives from the Maryland General Assembly
  - Charged with addressing Maryland's climate challenge on all fronts
- Three specific areas of concern:
  - Mitigation
  - Adaptation
  - Science and effects in Maryland
- Workgroups established for each area
  - Considerable stakeholder involvement at the Workgroup level
- Initial report by November 2007
  - Final Action Plan by April 2008

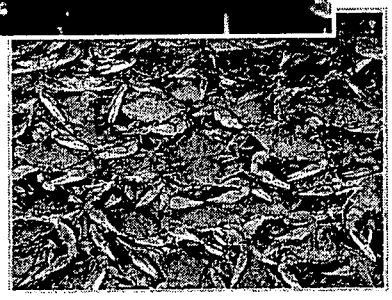




The November Interim Report

- Copies available
- Early Action Items
  - 2008 legislative initiatives
    - Global Warming Solutions
    - Energy Efficiency Bundle
    - Others
- Setting goals is one of the key pieces of state climate action plans
  - The Governors Executive Order asked the Commission to provide recommendations on goals in the November report
  - EO asked Commission to consider
    - 1990 levels by 2020
    - 80% reduction from 2006 by 2050
- MDE asked to discuss Maryland's goal setting process





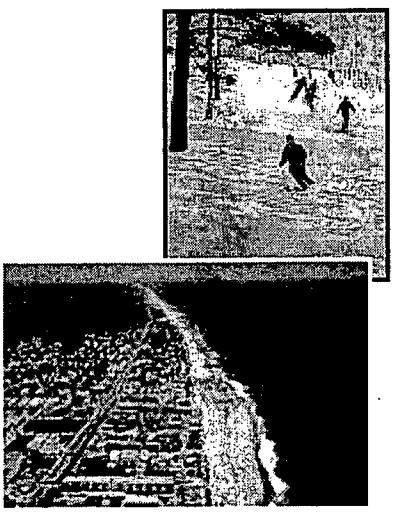
Recommendation on Goals

- **2012 - 10% below 2006 levels (using a consumption based approach)**
  - Used to drive early reductions and as a reduction target for the State Action Plan
- **2015 - 15% below 2006 levels**
  - Used as a early reduction target for the State Action Plan
- **2020 - 25% below 2006 levels by 2020**
  - Used as the "minimum" driver for Global Warming Solutions legislation
    - Programs to implement GWS will reward over-control
  - 50% also include as a science-based target for the 2020 time-frame
    - Very aggressive target, but consistent with recommendations from the IPCC
    - To be linked to implementation of broader regional effort or national program
- **2050 - 90% below 2006 levels**
  - Used as reduction target for the State Action Plan
  - Pushes research and innovation towards carbon neutrality
- **Mid-Course Review every 4 years**

WILL RETURN TO THESE LATER

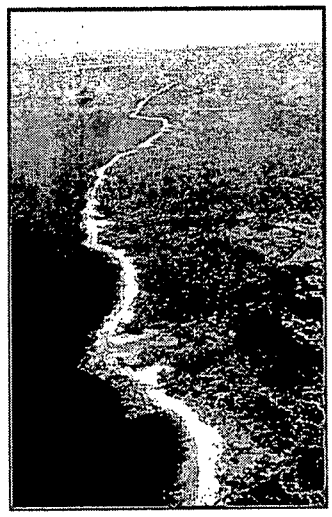
How We Got There

- What are the key questions?
- What are the basic policy choices?
- Maryland's six step process to decide on Goals



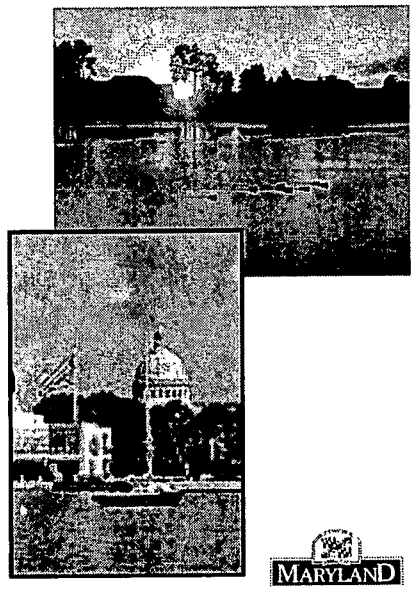
Goals or Standards?

- State climate action plans use goals as the basis for developing a plan
  - This is similar to the State Implementation Plan (SIP) concept used for ozone and fine particle nonattainment
  - A plan may contain 50 to 100 individual regulations or programs
- The individual elements of the plan often contain enforceable standards
  - Maryland Clean Cars, RGGI, etc.
  - These rulemakings involve stakeholders and follow State public participation procedures
  - This is where the "Plan" gets most of its teeth



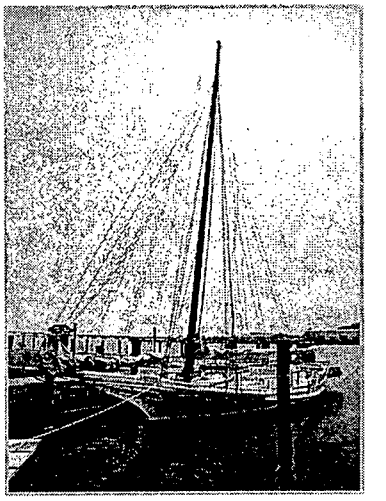
Goals for a Trading Program?

- Some states, like California and New Jersey, have also set goals to drive an economy-wide trading program
  - Global Warming Solutions
- The details of how the trading program will work are to be determined as part of regulations to be adopted by the state
- Cap-and-trade concepts and other market-based, trading mechanisms are being considered



Short or Long Term Goals?

- Most states have set both short and long-term goals
  - Short term
    - 2010/2015
  - Mid term goals
    - 2020/2025
  - Long term goals
    - 2050 and beyond
- Early goals are generally more "concrete"
- Later goals are often more "aspirational"



Updating the Goals?

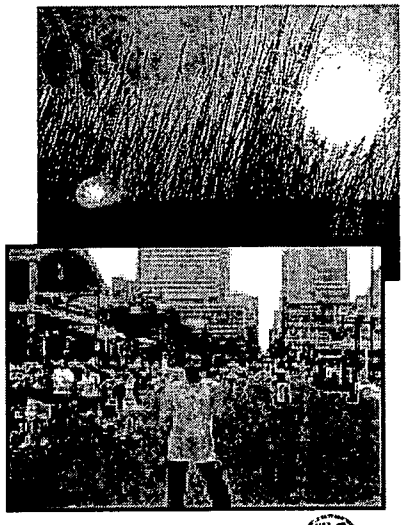
- Most state action plans recognize the need to update action plans and goals if necessary
- Again …
  - Earlier goals are often more certain and "regulatory"
  - Later goals are intended to be "tweaked" as programs are actually implemented and science and data improves





Purpose?

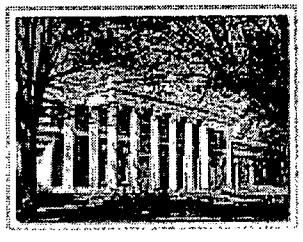
- What is the primary purpose of the goals?
  - One extreme
    - To set minimum targets consistent with what we know we can do
      - Builds from currently available programs and technologies
  - The other
    - To push the envelope on current, evolving and new pollution control programs
      - Often driven by where the science seems to tell us to go
      - Approach of current leadership states



Understanding "The Science"

- What message is the science sending us?
  - Reductions as high as 80% to 90% may be called for by around 2050 (2006 base)
  - Earlier reductions in the 25% to 50% range by 2020 (2006 base) may be needed to avoid the IPCC's most catastrophic forecasts.
  - Reductions that are earlier are better
    - 1 ton reduction in 2010 is much better than a 1 ton reduction in 2050
  - Reductions greater than 2020/2050 targets would provide significant additional benefits
  - Three simple themes
    - Earlier is better
    - Deeper is always better
    - Try hard



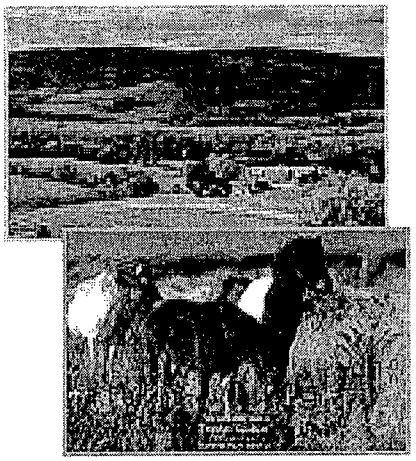


A Sampling of State Targets

State	1990-2020 GHG Forecast	State Goals	Climate Plan Coverage
Arizona	144%	2000 levels by 2020; 50% below by 2040	106%
California	40%	E.O.: 2000 level by 2010; 1990 by 2020; 80% by 2050 AB-32: 1990 levels by 2020	100%
Colorado	81%	?	TBD
Connecticut	32%	1990 level by 2010; 10% below by 2020; 75% by 2050	100%
Florida	?	2000 level by 2017; 1990 level by 2025; 80% below 1990 by 2050	?
Massachusetts	?	1990 level by 2010; 10% below by 2020; 75% by 2050	?
Maine	34%	1990 level by 2010; 10% below by 2020; 75% by 2050	100%
Maryland	52%	From 2006 levels: 10% below in 2010, 15% below in 2015, 25% below in 2020 and 90% below in 2050.	TBD
Minnesota	48%	Next Generation Energy Act: 15% below 2005 levels by 2015; 30% by 2025; 80% by 2050	TBD
Montana	31%	1990 level by 2020; 80% below by 2050 (consumption & production)	89%-105%
North Carolina	113%	?	TBD
NEG/ECP	?	1990 level by 2010; 10% below by 2020; 75-85% ultimately	TBD
New Jersey	?	E.O. 54: 1990 level by 2020; 80% below 2006 levels by 2050	TBD
New Mexico	65%	2000 level by 2012; 10% below by 2020; 75% below by 2050	133%
New York	24%	5% below 1990 by 2010	?
Oregon	52%	1990 level by 2010; 10% below by 2020; 75% by 2100	85%
Puget Sound	37%	1990 level by 2010; 10% below by 2020; 75% by 2100	100%
Rhode Island	35%	1990 level by 2010; 10% below by 2020; 75% by 2050	100%
Vermont	26-59%	25% below 1990 levels by 2012; 50% below 1990 by 2028; 75% by 2050	TBD
Washington	40%	E.O.: 1990 levels by 2020; 25% below 1990 by 2035; 50% below 1990 by 2050	TBD
WCI	54%	- TBD	TBD

Key Policy Choices

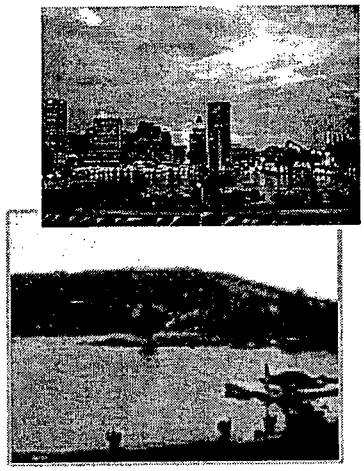
- Aspirational or bottom-up goals?
  - Where we'd like to go or…what we know we can currently do
- Science based?
- State specific plan or to lead by example?
- Short-term goals or long-term goals?
- To push control programs
  - Or to capture known programs?
- To guide plan development or to set enforceable targets?



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Aspirational or Bottom-Up?

- Clearly want to strive to meet or exceed reductions that the sciences tells us may be needed
- Maryland has much at risk
  - "Clean Hands" and "Leadership"
    - Both important
- Also need to balance these goals with current understanding of how implementation will work and costs
  - Especially for earlier deadlines that are regulatory in nature
- Is there a way to build both the aspirational goals and the realities of implementation into the goal setting process?

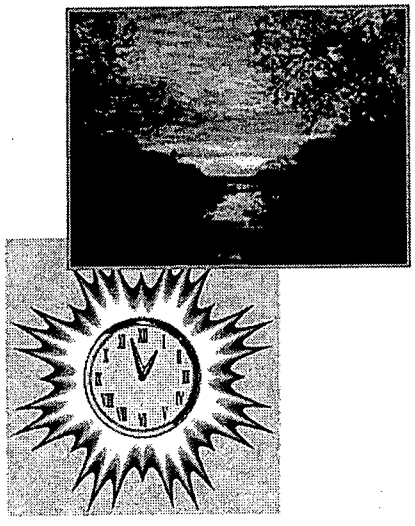


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Short-Term or Long-Term?

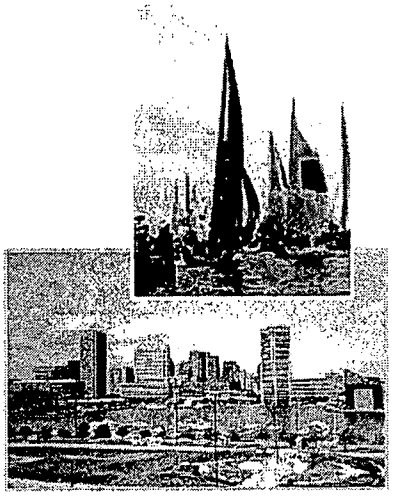
- Most state plans seem to have both short- and long-term goals
- Short-term strategies may be different than long-term strategies
  - Short-term goals are often more "regulatory"
- Key dates from other state plans include
  - Early (2010 to 2015)
  - 2020
  - 2050
  - 2100



MARYLAND

Permanent or To Be Updated?

- Climate science will continue to improve rapidly for the next 10 years
- Many policy innovations are currently being discussed and in some cases tested
- A routine update of the plan – including the goals – seems like a given
- Updates could be used to move the plan in several different directions



Regulatory or "Plan" Targets

- Most state action plans use goals as targets in developing state action plans
  - Individual "Plan" elements are enforceable
- Some states have used goals as regulatory drivers
  - California's AB 32/Global Warming Solutions
    - 1990 levels by 2020 through a trading program requirement
- Why can't we blend the two?

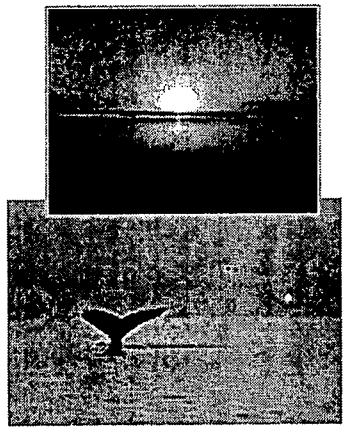




Maryland's Six Step Process

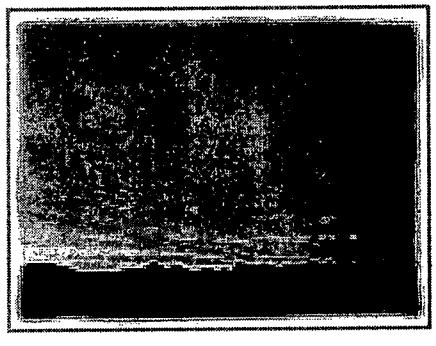
Step 1 – Consumption or Generation Based Goals?

- Most other state programs based on reducing emissions resulting from state consumption
  - MD imports about 30% of our electricity
- Generation based (emissions from within the state borders) approach is actually easier to implement (i.e. CAIR, RGGI)
- Consumption based inventories are also more difficult to develop
- Recommendation - Go with a consumption based approach for setting goals



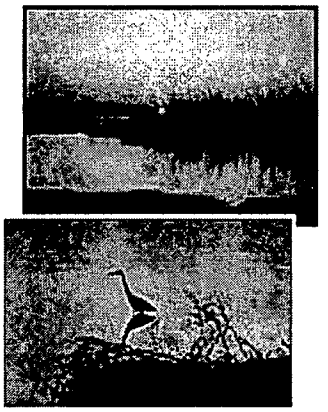
Step 2 – Base Year?

- Base years for other states bounce all over the place
  - 1990, 2000, 2005, 2006
- For Maryland, 1990 levels by 2020 is about the same as a 25% reduction from 2006 levels
- Recommendation – Use 2006 as the base year
  - Most recent data
  - Easiest to communicate the magnitude of the challenge
- Whenever possible:
  - Include comparisons to 1990



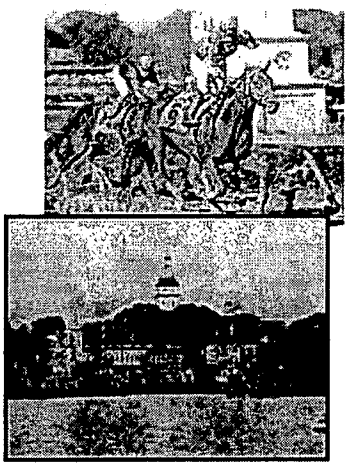
Step 3 – Aggressive or Bottom-Up?

- Maryland has much at risk
  - Goals must be aggressive and demonstrate leadership
  - Realities of implementation must be considered
- Use "Stretch" goals for Plan development
  - Goals not directly enforceable
  - Regulatory elements of the "Plan" would be enforceable
  - "Strive" to achieve type goals
- Use moderately cautious or moderately aggressive goal for 2020 trading programs
  - Enforceable
- Revisit and if necessary revise goals every 4 years



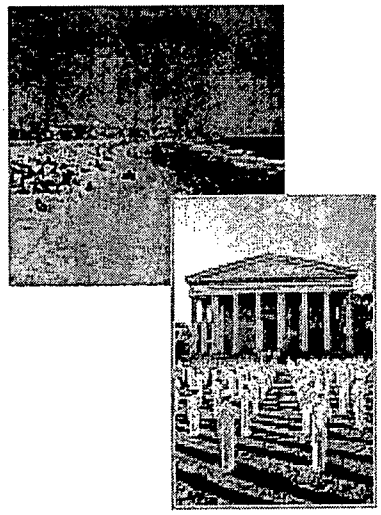
Step 4 – Target Years?

- Goals for different years often drive different policies
  - Early goals often drive short term – "currently available" strategies
  - Longer term goals often drive more slowly evolving strategies like smart growth and also push R & D.
- Most states include 2020 and 2050 goals
  - Some push for earlier reductions
- Recommendation – 4 target years
  - 2012 and 2015 to push for early reductions
  - 2020 to implement trading program
  - 2050 to drive longer term strategies and research and development



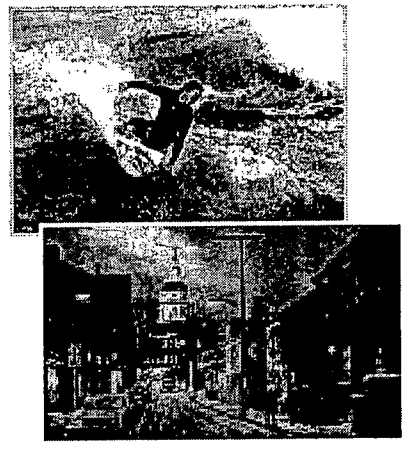
Step 5 – Regulatory or Targets

- Use both
- State action plan driven by "stretch" goals that are more like targets
  - Consistent with the science
  - Allows us to be bold and push the envelope
- Also include a regulatory goal for a Global Warming Solutions trading program
  - Moderately aggressive or moderately cautious to start
- All goals to be revisited every 4 years
  - Provides three mid-course review opportunities before 2020



Step 6 – Science Based?

- Use best, currently available science
  - IPCC and Maryland Scientific and Technical Workgroup
- Build from "what does the science tell us" themes
  - Push for early reductions
  - Deeper is better
  - Try hard
- Balance science-based targets and potential implementation concerns
  - For example, recent IPPC estimates of reductions needed by 2020 present a challenge
    - 25% to 40% below 1990 by 2020



Recommendation on Goals

- **2012 - 10% below 2006 levels (using a consumption based approach)**
  - **Used to drive early reductions and as a reduction target for the State Action Plan**
- **2015 - 15% below 2006 levels**
  - **Used as a early reduction target for the State Action Plan**
- **2020 - 25% below 2006 levels by 2020**
  - **Used as the "minimum" driver for Global Warming Solutions legislation**
    - **Programs to implement GWS will reward over-control**
  - **50% also included as a science-based target for the 2020 time-frame**
    - **Very aggressive target, but consistent with recommendations from the IPCC**
    - **To be linked to implementation of broader regional effort or national program**
- **2050 - 90% below 2006 levels**
  - **Used as reduction target for the State Action Plan and GWS**
  - **Pushes research and innovation towards carbon neutrality**
- **Mid-Course Review every 4 years**

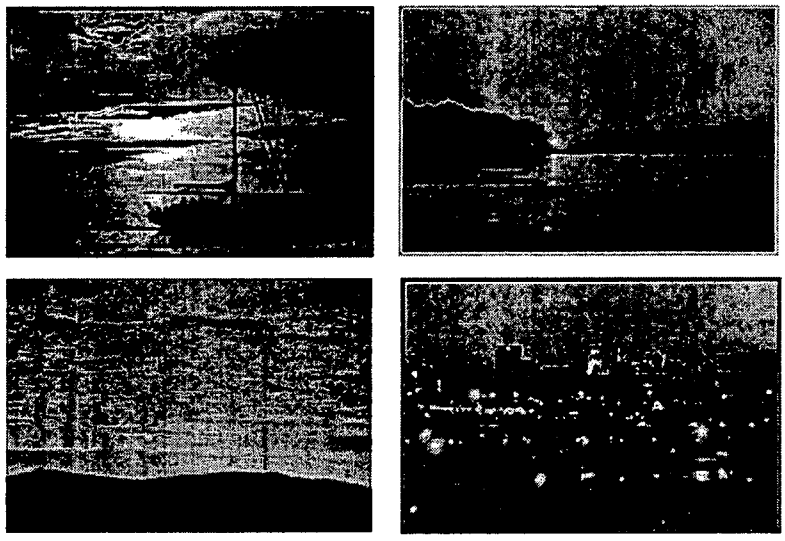
Other Leadership States

- California
  - 2000 levels by 2010
  - 1990 levels by 2020
  - 80% reduction by 2050
- New Jersey
  - 1990 levels by 2020
  - 80% below 2006 by 2050
- Florida
  - 2000 levels by 2017
  - 1990 levels by 2025
  - 80% below 1990 by 2050
- IPCC
  - 25% to 40% below 1990 by 2020
  - 80% to 95% below 1990 by 2050

MARYLAND'S GOALS

2010 – 10% below 2006 levels
= 15% above 1990 levels
2012 – 15% below 2006 levels
= 9% above 1990 levels
(about equal to 2000 levels)
2020 – 25% below 2006 levels
= 4% below 1990 levels
2020 – 50% below 2006 levels
= 36% below 1990 levels
2050 – 90% below 2006 levels
= 87% below 1990 levels

QUESTIONS?



Fear The Turtle

- January 19 – Tar Heels
- January 27 – Blue Devils



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pressrelease

FOR IMMEDIATE RELEASE: JANUARY 9, 2008
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N.C. ENERGY POLICY MODEL 'NOT CREDIBLE'

Peer review criticizes 'serious flaws' and questions results

RALEIGH – A model the Appalachian State University Energy Center used to project the economic impact of N.C. climate change policies has "serious flaws" that undermine its credibility. That's the verdict of a new peer review report from a Boston-based economic research group.

The John Locke Foundation is drawing attention to the peer review it commissioned from the Beacon Hill Institute at Suffolk University. The peer review raises red flags about the model's projections. "The Appalachian State Energy Center used this model to predict hundreds of thousands of new jobs and a major positive impact on North Carolina's economy," said Dr. Roy Cordato, JLF Vice President for Research and Resident Scholar. "Trained economists conducting this new peer review found that the model is so flawed that no one should trust the results."

The Locke Foundation commissioned the review because the N.C. Division of Air Quality chose not to submit the Appalachian State University study for an independent assessment, Cordato said. "A study that could have drastic impacts on North Carolina consumers and taxpayers needs a thorough, independent review of its validity."

The model officially called the North Carolina Energy Scenario Economic Impact Model, or NC-ESEIM, first appeared in 2005, according to the peer review. Last year, Appalachian State researchers used it to measure the economic impact of 31 policy options designed to reduce greenhouse gas emissions. Advocates target these emissions as a source of global warming.

"Unfortunately, the model has serious flaws that undermine its ability to forecast how changes in energy policy will impact wages, Gross State Product, and the number of jobs in North Carolina," according to report author Jonathan Haughton. Haughton is senior economist for the Beacon Hill Institute, founded in 1991 as the research arm of the Department of Economics at Boston's Suffolk University. Haughton is an associate professor of economics at Suffolk with an economics Ph.D. from Harvard University. "The model is so flawed that its results are not credible," he wrote in his peer review.

The first major problem with the Appalachian State study is its lack of

more >>

transparency. The university's Energy Center refused to provide access to its data when the Locke Foundation's *Carolina Journal* requested it. "Our comments are based on secondary sources, as we did not have direct access to the model or the underlying code," Haughton wrote.

Apart from the "lack of documentation and public access to the model," the Beacon Hill Institute peer review identifies several major flaws. The model uses a "multiplier analysis" that's inappropriate for an economy such as North Carolina's that has low unemployment. The model does not address correctly the impact of changing electricity prices tied to proposed energy policy changes. Plus the model uses assertions about investment that are "too optimistic" and assumptions about energy costs that are "implausible."

The incorrect use of the "multiplier analysis" leads to a questionable claim that new climate change policies would increase state employment by 23,500 jobs per year, according to the Beacon Hill Institute report. "In an economy with full employment, hiring someone for a new job essentially means bidding someone away from another job," Haughton wrote. "For the full multiplier effects to apply, one would have to assume that the state were in perpetual recession though 2020."

"This is Economics 101," Cordato said. "It's testimony to the fact that the Appalachian State Energy Center report lists no trained economists among its principal authors."

Cordato also draws attention to another finding that defies logic. "The Energy Center contends that North Carolina's economy — measured in Gross State Product — will rise when electricity is produced with greater inefficiency or expense," he said. "In other words, the Appalachian State University report says more expensive energy will somehow lead to more jobs. The peer review is correct when it labels this idea 'nonsensical.' Sound economics and common sense tell us that higher energy prices do not create more jobs."

Overall, the results tied to the NC-ESEIM are "not compelling," according to the Beacon Hill Institute assessment. "We are just beginning the great debate about the extent to which, and how, state governments should pursue policies to reduce greenhouse gas emissions," Haughton wrote. "Appropriate formal models to measure the economic impact of such policies will have an important role to play in this process, but it is essential that such models be credible and testable. The NC-ESEIM model falls short of this standard."

For more information, please contact Dr. Roy Cordato at (919) 828-3876 or rcordato@johnlocke.org. To reach Jonathan Haughton at the Beacon Hill Institute, call (617) 573-8750 or write to jhaughto@beaconhill.org. To arrange an interview, contact Mitch Kokai at (919) 306-8736 or mkokai@johnlocke.org.

-30-



Peer Review:

North Carolina Energy Scenario Economic Impact Model[1]

December 2007

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[1] This note was written by Jonathan Haughton, and benefited from comments by Ben Powell. Please send any comments or questions to jhaughto@beaconhill.org .

Introduction

The North Carolina Energy Scenario Economic Impact Model (NC-ESEIM) was developed to quantify the potential impacts on the state economy of major energy policy initiatives designed to reduce greenhouse gas emissions.

Unfortunately, the model has serious flaws that undermine its ability to forecast how changes in energy policy will impact wages, Gross State Product, and the number of jobs, in North Carolina. This peer review summarizes the NC-ESEIM, explains the flaws in the model, and provides suggestions of what would need to be done to create a reliable model.

Our comments are based on secondary sources (Ponder and Tiller 2007, Tiller (undated), and Rose and Wei 2005), as we did not have direct access to the model or the underlying code. A companion briefing paper presents a broader critique of the policies proposed to reduce emissions of greenhouse gases.[2]

The model

The NC-ESEIM was developed by Skip Laitner in 2005 and reviewed by Adam Rose and Dan Wei in the same year.[3] In 2005 it was used to measure the economic impact of establishing a state-level "Public Benefit Fund" to support energy-saving measures, and to examine the impact of state renewable portfolio standards (which would mandate that an increasing share of electricity come from renewable sources). In 2007 it was used by researchers at Appalachian State University to measure the economic impact of 31 policy options developed by the Center for Climate Strategies (CCS) for the North Carolina Climate Action Plan Advisory Group (NC-CAPAG). A similar model has been applied to a comparable set of policy options in several other states, including Arizona, Colorado, Florida, Iowa, Michigan, Ohio, and Texas.

Suppose a state government were to tax electricity sales enough to raise $1 million for a "Public Benefit Fund" whose proceeds would be used to fund a demonstration project showing how to achieve energy conservation. How might one measure the impact of such a measure? This is the type of question that the NC-ESEIM is designed to answer.

To be able to say more, some further assumptions are needed. Suppose, for now, that the demonstration project spawns three conservation projects of comparable size that are privately financed. This will raise private investment by $3 million, pushing up the demand for wood and cement and steel, which in turn will raise the demand for chainsaws and clinker and iron ore, in a chain of "indirect" effects that work through to most of the sectors of the state economy. Meanwhile, the workers on the new private projects will spend some of their new income locally, raising demand for goods and services in a chain of "induced" effects. If there is some initial slack in the economy, the indirect and induced multiplier effects can be expected to increase the number of jobs and boost incomes.

This is the classical "multiplier analysis" treatment of an investment. But the NC-ESEIM model has been designed to address energy issues, and there are two further considerations: first, the private investments lead to savings in the quantity of energy used (and imported), and this leaves residents with more money

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[2] *North Carolina Climate Action Plan Advisory Group Recommended Mitigation Options for Controlling Greenhouse Gas Emissions*, (Beacon Hill Institute: Boston, December 2007) available upon request

[3] Skip Laitner is a Visiting Fellow and Senior Economist at the American Council for an Energy-Efficient Economy. Dan Wei is part of "the CCS [Center for Climate Strategies] team" that has developed policy options for climate mitigation in North Carolina.

to spend on other items, which in turn boosts Gross State Product. Second, power generating costs change over time (at fixed annual rates, depending on the fuel). Indeed, the model assumes that the cost of producing electricity from renewable sources (e.g. wind, biomass, hydropower), which starts high, falls below the cost of generating electricity from conventional fuels, by 2016.

Although this sketch captures the essence of the NC-ESEIM, the actual model is of course more complete and complex. In its original form, it was used in 2005 to analyze the effects of:

(i) introducing renewable portfolio standards, which mandate that a rising share of electricity production come from renewable sources; and

(ii) establishing a Public Benefit Fund that would spend on public education, demonstration projects, and research and development; and would provide low interest revolving loans, as well as grants and tax credits. These would be geared mainly to improving energy efficiency in the residential, commercial, and industrial sectors.

The original model traces the effects of these policies through an input-output table with 20 sectors.

The results of the base Public Benefit Fund case are shown in Table 1 (from Rose and Wei). The model shows a small drop in employment in the first year (before energy savings kick in), but a rise in jobs and wage payments thereafter; GSP also falls initially, then rises, and drops again after 2016, when falling electricity prices (due to low-cost generation from renewables) reduce the amount of dollars received by the local utility sector, and because "the revenue losses in utility sectors outweigh the gains in other sectors" (Rose and Wei, p.8).

Table 1. Effects of an NC Public Benefit Fund for energy conservation on jobs, wages and Gross State Product, as projected by the NC-Energy Scenario Economic Impact Model

	2005	2006	2007	2008	2009	2010	2011	2012
Jobs	-73	212	2,300	1,463	1,838	1,869	2,012	2,371
Wages ($m, 2000 prices)	-2.3	3.1	64.4	35.5	43.7	41.6	43.0	51.3
GSP ($m, 2000 prices)	-4.2	-5.9	98.3	34.0	32.8	14.1	0.8	-1.2
	2013	2014	2015	2016	2017	2018	2019	2020
Jobs	3,234	3,752	4,255	3,277	3,753	4,152	4,656	5,137
Wages ($m, 2000 prices)	74.1	87.5	100.7	67.3	80.2	90.5	105.0	119.3
GSP ($m, 2000 prices)	12.5	13.3	14.0	-63.9	-83.5	-69.8	-68.4	-67.0

Source: Rose and Wei (2005), p.11.

In the 2007 simulations based on the model, researchers at Appalachian State University found that a raft of 31 policy measures would, collectively, increase employment in the state by about 23,500 annually (equivalent to 0.54% of current employment), boost income by just over $1 billion per year, and raise Gross State Product by $1.47 billion (or by 0.39% of current GSP).

Flaws

The model is so flawed that its results are not credible. There are four serious problems – apart from the lack of documentation and public access to the model – which are listed here and discussed in further detail below.

1. The use of a multiplier analysis is not appropriate in a full-employment context.
2. The model does not allow the changing price of electricity to affect production or determine the price deflator (inflation) component of Gross State Product (GSP), with the ultimately nonsensical result that GSP is projected to rise when electricity is produced inefficiently (more expensively), and to fall when electricity is produced with higher efficiency (less expensively). If this were true, we should welcome higher energy prices and high inflation because it increases nominal GSP.

3. The assertions about what determines investment – the key driver of this input-output model – are too optimistic.
4. The assumptions about the evolution of energy costs over time are implausible.

Problems (1) and (2) could be remedied with the use of a computable general equilibrium model (as noted by Rose and Wei, p.5), while the issues raised in (3) and (4) could be addressed on the basis of a wider review of the available literature.

Flaw 1. Multipliers

It is appropriate to count the full multiplier effects of additional spending only if an economy initially has significant amounts of underused resources – spare industrial capacity, for instance, or a high level of unemployment. Under such circumstances, an additional $10 of spending will increase the demand for inputs (the indirect multiplier effects) and put spending power into the hands of workers (creating induced multiplier effects), so employers will hire more workers and use their machines more intensively.

However, in an economy with full employment, hiring someone for a new job essentially means bidding someone away from another job, so that the net effect on incomes and output is minimal.

By counting all the multiplier effects, the preliminary simulations undertaken by the Appalachian State University team are implicitly assuming that there is consistently expected to be slack capacity in the North Carolina economy over the coming decade, and that one could hire an additional 23,500 people in the state without any effect on the output of other sectors in the economy (Ponder and Tiller 2007). This is not plausible. The unemployment rate in North Carolina stood at 4.8% of the labor force in October 2007, statistically indistinguishably from the national rate of 4.7%, and a rate that indicates that there is little underused capacity in the state. For the full multiplier effects to apply one would have to assume that the state were in perpetual recession though 2020!

Flaw 2. Lack of price feedback

The NC-ESEIM model does not include a mechanism whereby a change in the price of electricity feeds into the cost of producing goods and services in the state. Furthermore, the simulations report measures of wage income and of Gross State Product (GSP), but they are nominal rather than "real" values because they do not adjust for the changes in the cost of living that would be expected if the price of electricity were to change.

These are not esoteric points. Consider the case of the introduction of a Renewable Portfolio Standard (RPS); under the NC-ESEIM model, the cost of producing electricity would rise until 2016, after which it would fall because the cost of renewables-based electricity would, it is assumed, drop below the cost producing electricity from fossil fuels. Economic logic dictates that if one does not take the value of greenhouse gas reductions into account (which the model does not), the introduction of the RPS should first reduce real GSP (because one is generating some energy inefficiently) and then raise real GSP (because technological change has reduced the cost of producing energy).

Yet the NC-ESEIM model does not show this! Instead, it projects rising GDP throughout the 2006-2020 time horizon, with a *smaller* net gain in GSP after 2016 (when renewables have become especially efficient).

Flaw 3. Determinants of investment

If state government spends a million dollars on a program designed to leverage private investment in order to conserve energy, how much additional private spending is likely to occur, and how much energy will be saved? The key relevant assumptions made by the NC-ESEIM model are set out in Table 2.

So, for instance, when the state spends $1m on demonstration projects, it is assumed in the model that residential investment on conservation will rise by $3m. It is assumed that the private investment will be recouped in 5.07 years, as a result of the reduction in energy costs.

The assumptions are optimistic. For example, private commercial and residential investment in energy conservation is assumed to pay back the original investment in less than two and a half years; if the investment lasts for ten years that represents a generous 38% rate of return. One might legitimately ask how many unexploited opportunities such as this are still available. (If there are, count us in, we're interested!)

Public education is assumed to be particularly effective; every dollar spent is expected to save at least two dollars in energy, a handsome annual rate of return of no less than 100%.

Table 2. Assumptions used in the NC-ESEIM model about the effect of additional state spending, related to energy conservation, on private investment and on energy savings

		State spending of $1m spawns private investment of ($m):	... and annual energy savings, per dollar of state spending, of ($):	Memo: Energy savings payback period (years)
Demonstrations	Residential	3.0	0.59	5.07
	Commercial	2.0	0.85	2.35
	Industrial	1.0	0.44	2.26
Grants	Residential	2.86	0.56	5.07
	Commercial	2.63	1.12	2.35
	Industrial	2.63	1.16	2.26
Loans	Residential	5.56	1.10	5.07
	Commercial	5.56	2.37	2.35
	Industrial	7.41	3.28	2.26
Research & Development			2.0	0.50
Public Education	Residential		3.0	0.33
	Commercial		2.0	0.50
	Industrial		2.5	0.40

Source: Rose and Wei (2005).

We do not wish to imply that state spending to encourage conservation would have no effect on investment or energy savings, but we do wish to suggest that the gains are being oversold here; a similar point has been made by Paul Joskow and Donald Marron (1992), and is still relevant.

Flaw 4. Energy cost assumptions

Technological improvements have gradually reduced the real cost of producing electricity out of a given quantity of conventional fuel such as coal, natural gas, oil, or uranium. Similar technical improvements are reducing the cost of producing electricity from wind, biomass (such as wood), methane (from landfills), and from the sun (photovoltaics and other systems), but most of these renewable technologies are still significantly more expensive than the conventional sources.

The idea behind a Renewable Portfolio Standard (RPS) is to require a larger and larger share of electricity to come from renewable sources. Such a standard would not be needed if renewable technologies were already cheaper.

But the NC-ESEIM assumes that, from 2016 onwards, electricity from renewable sources ("green electricity") will become less expensive than that from conventional fuels **because of the North Carolina renewable portfolio standards**. If the reduction in the cost of green electricity is not due to the renewable portfolio standards, then the effects of such a cost reduction cannot be attributed to the RPS, and any simulation that assumes this would be incorrect – which would imply that the analysis of the effects of the RPS should end in 2016, at which point the program has reached the end of its useful life.

But if the North Carolina RPS causes lower costs for green electricity, how is the mechanism supposed to work? It is not credible that the learning by doing that would take place just in North Carolina would be enough to have a discernible impact on the cost of green electricity there, *relative to an appropriate counterfactual* under which the cost of green electricity might fall anyway. The NC-ESEIM model assumes a learning rate – i.e. a rate at which production costs fall over time – that is constant over time for each type of electricity generation; it appears that the learning rate is permanently higher for renewable energy sources, but it is far from clear why this should be so.

Conclusion

It is not straightforward to analyze the economic impact of state policies that are designed to reduce greenhouse gas emissions. The North Carolina Energy Scenario Economic Impact Model (NC-ESEIM) represents a serious and concerted effort to measure the relevant effects on jobs, incomes, Gross State Product, and energy use.

But the results of the NC-ESEIM model are not compelling, for the reasons we have set out in this note. By using a demand-driven input-output analysis at its core, the model assumes that the state economy has slack capacity; and it lacks an adequate mechanism for energy prices to feed back into measures of real incomes or investment decisions. These could be addressed by developing a computable general equilibrium model in which prices are allowed to adjust, but such models are themselves complex and difficult to construct. The NC-ESEIM also makes unduly optimistic assumptions about the future course of cost reductions in the production of energy from renewable sources, and is too sanguine about the potential for state spending to trigger private investment, and influence individual behavior, in energy conservation.

We are just beginning the great debate about the extent to which, and how, state governments should pursue policies to reduce greenhouse gas emissions. Appropriate formal models to measure the economic impact of such policies will have an important role to play in this process, but it is essential that such models be credible and testable. The NC-ESEIM model falls short of this standard.

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The Beacon Hill Institute at Suffolk University in Boston focuses on federal, state and local economic policies as they affect citizens and businesses. The institute conducts research and educational programs to provide timely, concise and readable analyses that help voters, policymakers and opinion leaders understand today's leading public policy issues.

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North Carolina
Climate Action Plan Advisory Group

Background for a Process on Adaptation to Climate Change in North Carolina

January 16, 2008

The Center for Climate Strategies

Initial Questions

- What is of concern?
  - Coastal areas?
  - Water resources?
  - Human health?
  - Agricultural production?
- Who/what are affected?
  - Homeowners?
  - Farmers?
  - Small businesses?
  - Citizens' health and safety?
- How far into the future?
  - Current risks v. long-terms risks?

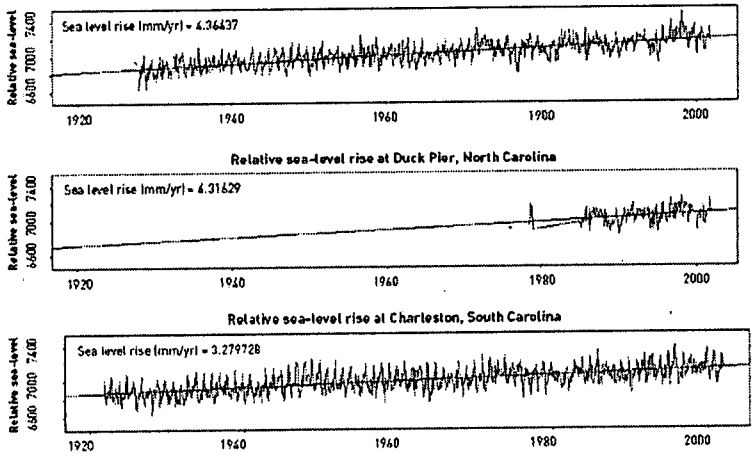
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Initial Questions (continued)

- For what purpose is the process?
  - Raising awareness?
  - Making policy?
  - New legislation?
- What kinds of outputs are needed?
  - Research studies?
  - Near-term adaptation actions?
  - Long-term policy direction setting?
- What resources are available?
  - Time?
  - Capacity?
  - Funds?

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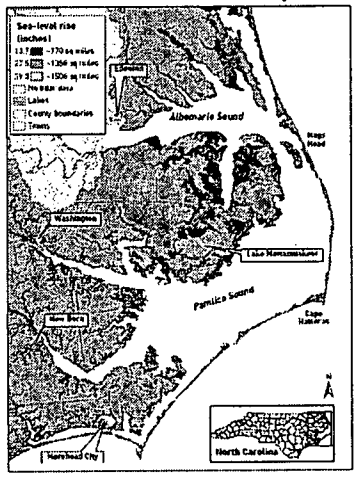
Climate Change Risks in NC – Sea Level Rise



Source: Ben Poulter, Duke University, as cited in "Understanding Global Warming for North Carolina" by A. Munger and M. Shore

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Climate Change Risks in NC – Sea Level Rise (cont'd)



Source: Ben Poulter, Duke University, as cited in "Understanding Global Warming for North Carolina" by A. Munger and M. Shore

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Other Risks for NC from Climate Change

- Higher temperatures would lead to air quality problems and accompanying health problems
- The natural environment of NC will likely be altered
- The state economy will likely be adversely affected.

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Vulnerability to the Risks of Climate Change

- Vulnerability is the level of risk associated with adverse impacts of climate change on NC resources and economy
- Vulnerability is a function of:
  - Exposure (to climatic extremes and volatility)
  - Sensitivity (to that exposure)
  - Adaptive capacity (the State's ability to adapt)

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Exposure

- What specifically is at risk in NC?
  - Populations
  - Resources
  - Property
- What will be affected in NC?
  - Sea level
  - Temperatures
  - Rainfall
  - Frequency of extreme events

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Sensitivity

- What specifically are the physical effects of climate change in NC?
  - Rainfall runoff?
  - Crop yields?
  - Demand for electricity and other energy forms

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Adaptive Capacity

- What specifically is the ability of NC to adapt? Typically, a function of
  - Wealth
  - Technology
  - Institutions
  - Legislation
  - Public awareness
  - Infrastructure

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Vulnerability Is Affected by Interactions Between All Three

- More exposure and sensitivity increase vulnerability
- More adaptive capacity decreases vulnerability
- Any process in NC should consider all three factors

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Adaptation Option Design Template

- Option Description (Concept)
- Option design (Targets, timing, parties involved, other)
- Implementation Mechanisms
- Related Policies/Programs in place
- Estimation of adaptation options relative to
  - Costs
  - Flexibility
  - Adaptive capacity
  - Other
- Documentation of adaptation benefits and costs
  - Data sources
  - Quantification methods
  - Key assumptions
  - Key uncertainties
  - Additional Benefits and Costs
  - Feasibility Issues, if Needed
- Status Of Group Approval
- Barriers to Consensus

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Adaptation to Climate Change

- The IPCC defines adaptation to climate change as:
  - "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (Third Assessment Report, Working Group II)

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Two Major Types of Adaptation to Climate Change

- Autonomous or reactive adaptation: tends to be what people and systems do as impacts of climate change become apparent
- Anticipatory or proactive adaptation: measures taken to reduce potential risks of future climate change
- The latter type is what an NC adaptation process would focus upon

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Potential Adaptation Options

- CCS has developed a catalog of options for the following vulnerable sectors
  - Coastal zones
  - Human health
  - Natural resources
- Catalog comprised of 200+ options
- Potential starting point for the consideration of adaptation options in NC

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Adaptation Options - Illustrative Set of Options (Maryland)

Option No.	Adaptation Policy Option	Flexibility	Capital intensity	Adaptive capacity	Level of consensus	Notes
1	Operation activities					
1.1	Develop operational protocols that specify disclosure requirements for coastal hazards					
1.2	Improve hazard preparedness of residential homes and commercial entities by providing operational assistance or incentives					
1.3	Assess sea level rise hazard insurance for businesses as part of standard operations					
1.4	Assess sea level rise hazard insurance for home owners in inundation hazard zones					
1.5	Implement standardized community education materials on hazards that addresses the relationship between climate variability and climate change					
1.6	Evaluate shoreline erosion buffers for zones subject to flooding in which significant infrastructure is located					
1.7	Develop and implement a tree planting program along vulnerable coastal areas as a flooding control strategy					
1.8	Prevent further development in sensitive areas subject to sea level rise hazards	*Noted here but recommend to move to future built environment & infrastructure adaptation option catalog*				
1.9	Require that new development not infringe upon the sensitive shoreline areas subject to sea level rise hazards	*Noted here but recommend to move to future built environment & infrastructure adaptation option catalog*				
1.10	Minimize the installation of paved surfaces as a strategy for flood runoff control	*Noted here but recommend to move to future built environment & infrastructure adaptation option catalog*				

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Broad Outline of an Adaptation Process in NC

- Fact-finding (developing a vulnerability baseline – this helps establish the scope of technical working groups)
- Stakeholder process (identifying vulnerable sectors and scoping out a set of priority adaptation options)
- Recommendations (converging on a specific set of recommendations for implementation)

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Potential Technical Working Groups in NC

- Coastal zones
- Water resources
- Human health
- Terrestrial ecosystems

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Priority Adaptation Option Design

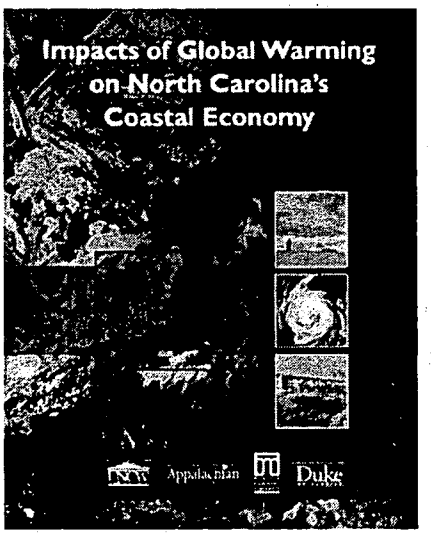
- Plenary Group identifies about 50 draft potential options for further development
- TWGs screen, prioritize, and propose initial policy option design ("straw proposals")
  - Timing
  - Goals
  - Coverage
- CCS facilitates a process of evaluation and presents for review
- Plenary Group revisits list of potential priorities, as needed

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Adaptation Option Design Template

- Option Description (Concept)
- Option design (Targets, timing, parties involved, other)
- Implementation Mechanisms
- Related Policies/Programs in place
- Estimation of adaptation options relative to
  - Costs
  - Flexibility
  - Adaptive capacity
  - Other
- Documentation of adaptation benefits and costs
  - Data sources
  - Quantification methods
  - Key assumptions
  - Key uncertainties
  - Additional Benefits and Costs
  - Feasibility Issues, if Needed
- Status Of Group Approval
- Barriers to Consensus

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NATIONAL COMMISSION ON ENERGY POLICY

East Carolina University

University of North Carolina WILMINGTON

Duke UNIVERSITY

Appalachian State University

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This research was supported by a grant from the William and Flora Hewlett Foundation to the Bipartisan Policy Center, Inc.

National Commission on Energy Policy Projects on Climate Change Impacts and Adaptation

In addition to the North Carolina project:

- Impacts of permafrost melt on infrastructure in Alaska
- Impacts on water resources in New Mexico & adaptation policy
- Impacts on forests & air quality in Tennessee
- Risks to Florida coastal property & adaptation policy
- Impacts on water supplies in Idaho
- Impacts on forests in the upper Rocky Mountains

Problem

- Climate change may have significant impacts on North Carolina coastal resources due to sea level rise, increased erosion, and increased hurricane activity and intensity.
- Extensive development in the coastal zone in recent decades has put more people and property at risk.

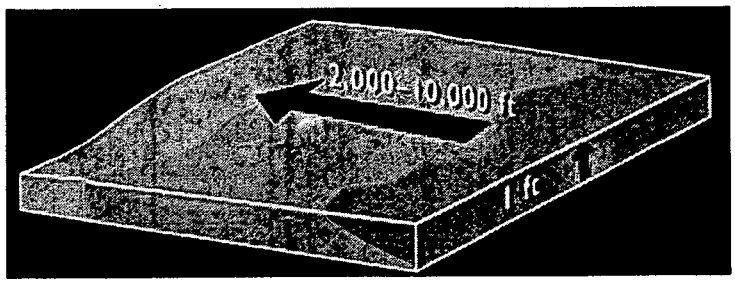
Climate change in coastal North Carolina

- Sea-level rise
  - Complete loss of many beaches
  - Lost property values
  - Lost recreational benefits
- Hurricane intensity increases
  - Business & tourism interruption
  - Agricultural losses
  - Greater damage to forests
  - Commercial fishing losses

Climate Models Behind the Analysis

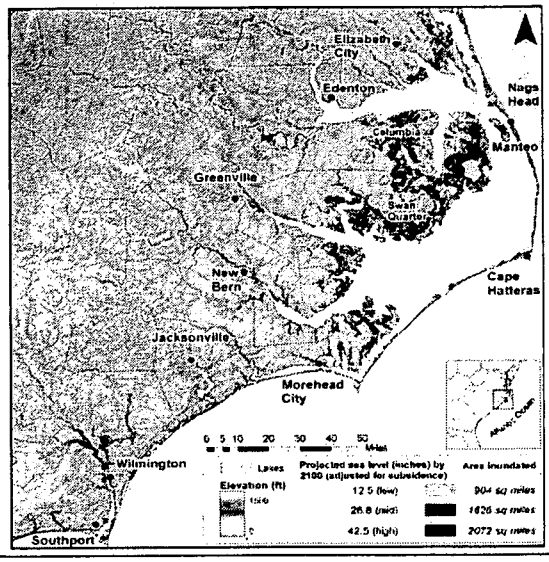
- Climate model results from IPCC Third Assessment Report. (Fourth Assessment was not ready yet.)
  - Houghton, J. T., Y. Ding, D. J. Griggs, M. Noguer, P. J. van der Linden, D. Xiaosu, and K. Maskell (eds.) 2001. Climate Change 2001: The Scientific Basis. New York: Cambridge University Press.
- Used mid-range numbers from results of over 20 global climate models covered in the IPCC report. (cccma cccma.t63 cnrm csiro gfdl0 gfdl1 giss.aom giss.eh giss.er iap inmcm3 ipsl miroc.hires miroc.medres echo echam mri ccsm pcm hadcm3 hadgem1)
- Sea Level Rise inundation model using 8-side rule for connectivity (see Poulter and Halpin, in review)
  - i. Uses lidar elevation data (±25 cm vertical accuracy)
  - ii. Generated binary flooded/not-flooded raster surface

Sea-level Rise and Coastal Inundation



- A one-foot rise in sea level can cause inland movement of the shoreline by 2,000 to 10,000 feet along the relatively flat North Carolina coast.

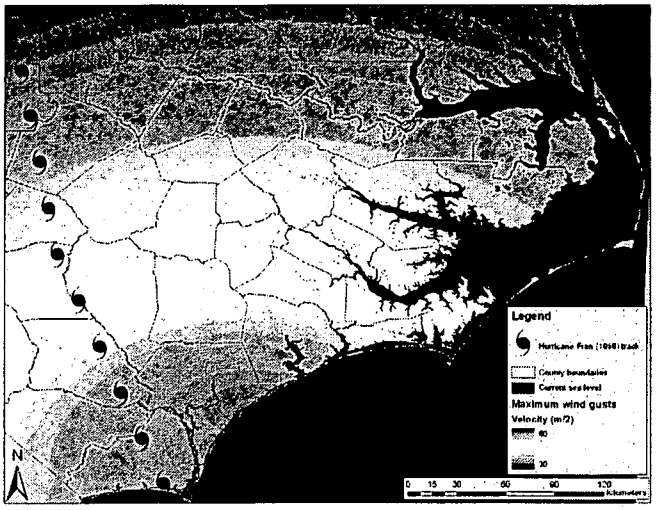
Land at risk due to sea level rise by 2100



Hurricane Intensity (Wind Speeds)

- Modified Hurrecon (Boose and Foster 2001) wind speed model
- Ran Hurrecon with track from Fran (1996) download from NOAA HURDAT website
  - Interpolated 3-hourly measurements from NOAA to 1-hourly intervals
  - Approximately 14 time points of Fran track recorded across NC
  - Generated maximum wind gust maps and maximum sustained wind velocity maps for each time point
  - Calculated maximum wind gust map for entire storm track (m per second)
- The scenarios are based on estimated changes in hurricane intensity by Knutson and Tuleya (2004). K&T examined estimated changes in hurricane formation in the Atlantic and Pacific oceans from nine climate models. They calculated a range of changes in sea surface temperature, intensity, wind speed, and precipitation
- Estimates of wind speed increases from MAGICC/SCENGEN for 2030 and 2080. The original 1996 wind speed map was multiplied by these percent increases to simulate a climate-change influenced Fran hurricane.

Hurricane Fran (Cat 3, 1996) Case Study



Changes in Hurricane Intensity

Hurricane categories for baseline and climate change scenarios

	Category 3 Hurricane (Hurricane Fran Track) Baseline Scenario	Climate Change Scenarios	
	1996	2030	2080
County	MAX	MAX	MAX
Bertie	TS	TS	TS
Carteret	1	2	2
Dare	TS	1	1
New Hanover	2	2	3

TS = tropical storm, 1 = category 1 hurricane, 2 = category 2 hurricane, etc.

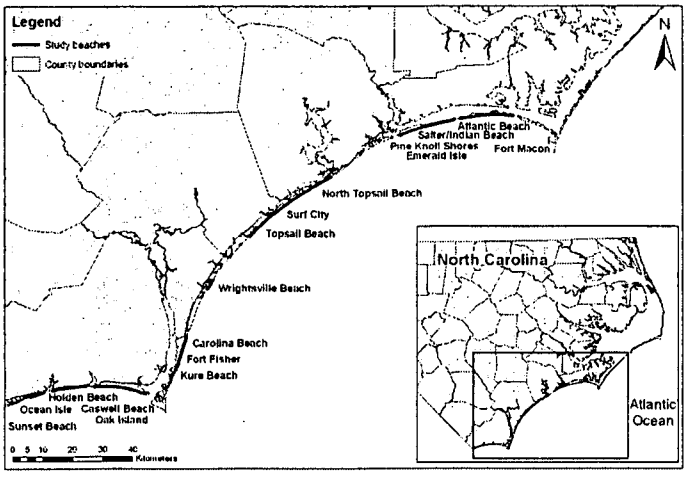
Within this physical science context, this study ...

- Considers the impacts of climate change on the
  - coastal real estate market
  - coastal recreation and tourism
  - business activity, agriculture and forestry
- Utilizes a range of mid-range assumptions for sea-level rise and hurricane intensity increases, not best- or worst-scenarios.
- Assumes no mitigation/adaptation—presents "What costs might be if no mitigation/adaptation is undertaken." Benefits of mitigation/adaptation activities are the avoidance of these costs.
- Is limited in geographic scope and types of impacts considered due to budget and time constraints.

Recreation Impacts



Study Beaches



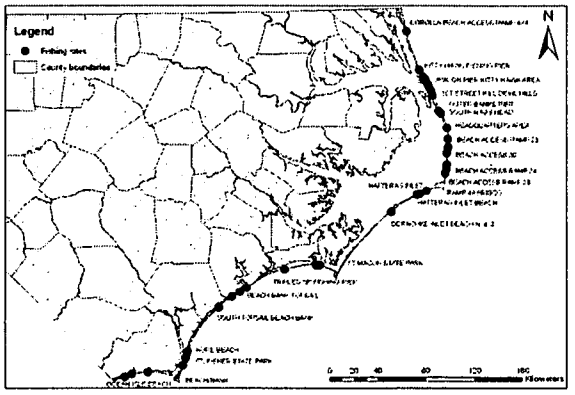
Beach Width (Assuming no mitigation)

County	Beach	2003	2030	2080
Carteret	Fort Macon	90	40	0
Carteret	Atlantic Beach	135	85	0
Carteret	Pine Knoll Shores	110	60	0
Carteret	Indian Beach / Salter Path	90	40	0
Carteret	Emerald Isle	130	80	0
Onslow-Pender	North Topsail Beach	82	32	0
Onslow-Pender	Surf City	90	40	0
Onslow-Pender	Topsail Beach	110	60	0
New Hanover	Wrightsville Beach	160	110	3
New Hanover	Carolina Beach	185	135	28
New Hanover	Kure Beach	130	80	0
New Hanover	Fort Fisher	400	350	243
Brunswick	Caswell Beach	80	30	0
Brunswick	Oak Island	120	70	0
Brunswick	Holden Beach	90	40	0
Brunswick	Ocean Isle Beach	85	35	0
Brunswick	Sunset Beach	115	65	0

Impacts on Recreation and Tourism

- Lost recreation value to local southern NC beach goers:
  - $93 million a year by 2030
  - $223 million a year by 2080
- Reduction in annual spending by non-local beach tourists visiting southern NC beaches:
  - 16% decline by 2030
  - 48% decline by 2080.
- Note: These are impacts for southern NC beaches only. Necessary data were not available for northern NC beaches.

Impacts on Shore Fishing--Fishing Sites

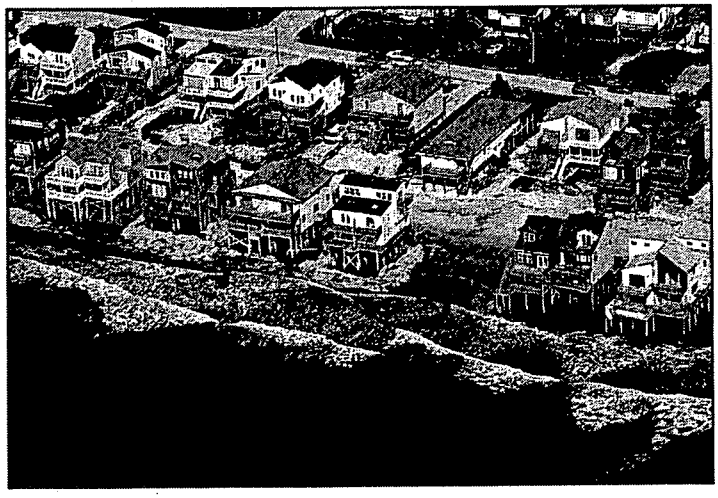


- 22 Piers
- 28 Beach

Impacts on Shore Fishing

- Based on MRFSS angler intercept data.
- The lost recreation value to local shore anglers (all NC beaches):
  - $15 million a year by 2030
  - $17 million a year by 2080
- Note: These are impacts for all NC beaches.

Coastal Real Estate

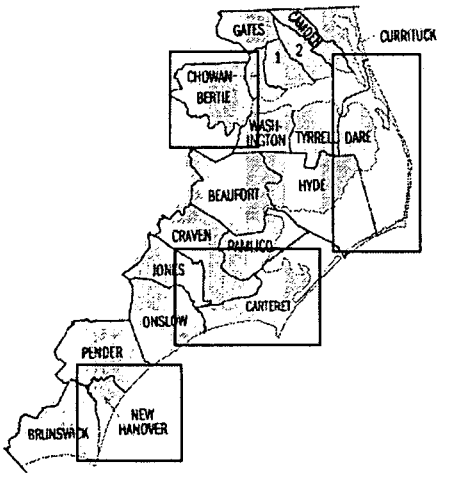


Study Area



Data

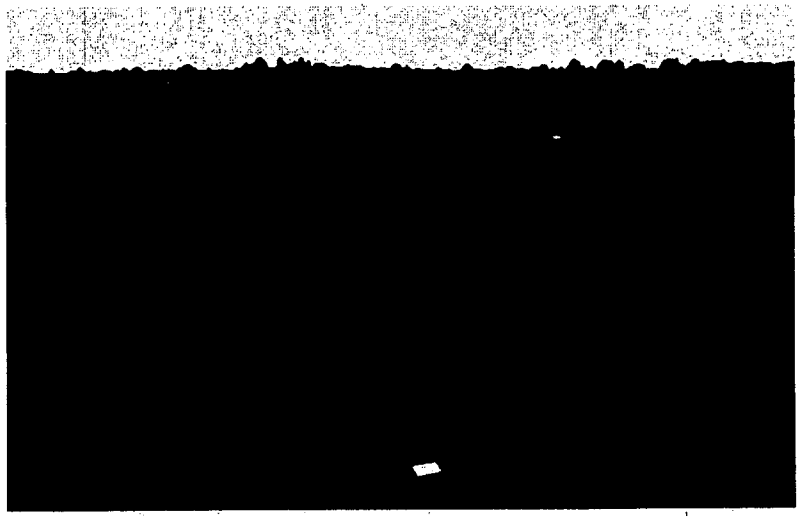
- Data on property values come from the county tax office.
- High-resolution LIDAR elevation data are utilized to identify the inundation areas.
- Other spatial amenities (e.g., distance to the shore) are measured using GIS.



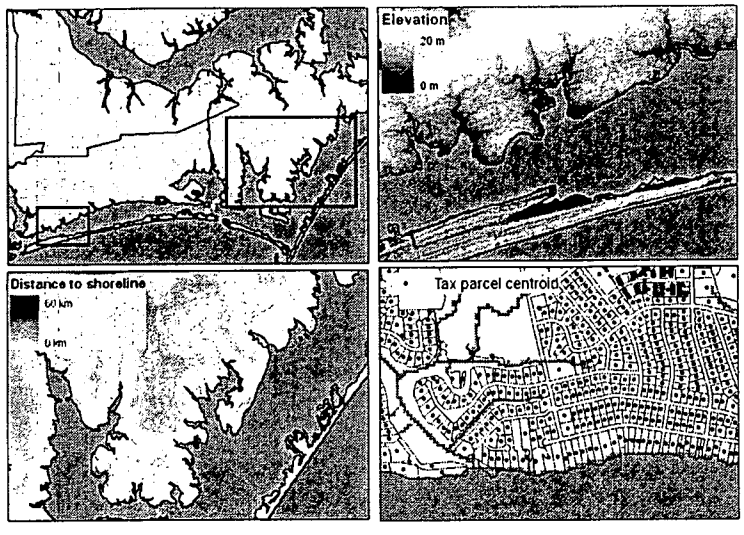
Data for New Hanover County

Variable	Description	Mean	Standard Deviation
AV	Real assessed property value as of May 2006	176,554.01	152,684.14
WRIGHTS	Wrightsville Beach township (= 1)	0.02	0.13
CAROLINA	Carolina Beach township (= 1)	0.04	0.20
KURE	Kure Beach township (= 1)	0.03	0.16
FIGEIGHT	Castle Hayne township (=1)	0.02	0.15
LOTSIZE	Total lot size measured in square feet	16,375.63	23,106.41
SQFT	Total structure square footage	1,786.05	798.79
AGE	Age of house	25.46	23.12
BATHRM	Number of bathrooms	2.23	0.85
AIRCOND	Central air conditioning (= 1)	0.90	0.30
FIREPLCE	Fireplace (= 1)	0.64	0.48
MULTISTR	Multistory house (= 1)	0.30	0.46
DETGAR	Detached garage (= 1)	0.07	0.26
OCEAN	On ocean front (= 1)	0.01	0.08
SOUND	On sound front (= 1)	0.02	0.12
DIST	Distance to nearest shoreline measured in feet	1,811.87	1,273.46
ELEV	Elevation of property measured in feet	26.21	12.14

LIDAR Data



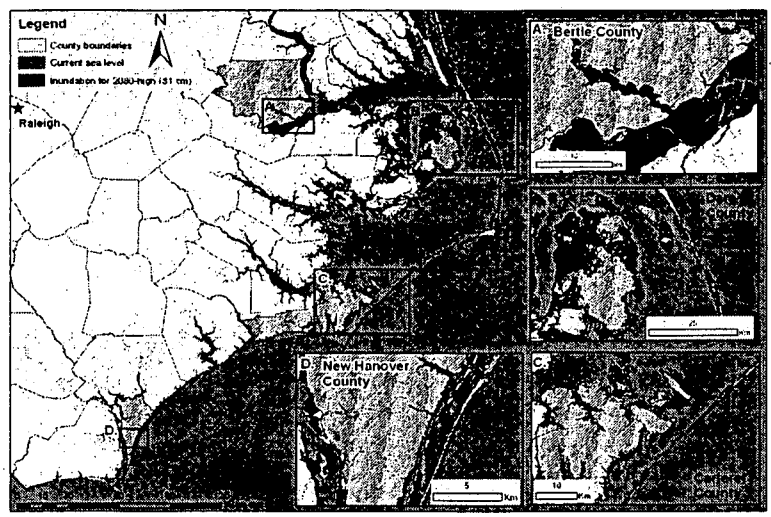
GIS Real Estate Data



Sea Level Rise Scenarios

Year	Scenario	Projected sea level rise (m)
2030	Low	0.11
	Mid	0.16
	High	0.21
2080	Low	0.26
	Mid	0.46
	High	0.81

Inundation for 2080-High



Hedonic Property Value Models

- Loss of property values due to SLR is estimated by a simulation approach based on the hedonic method.
- This approach links property value to structural, location, and environmental characteristics.
- Assume no adaptation that coastal communities and property owners may undertake as they observe sea level rise over time.

Estimation Methods

- The baseline hedonic models are estimated for residential & nonresidential properties.

$$\ln \boldsymbol{R} = \alpha + \sum_i \beta_i \boldsymbol{S}_i + \sum_j \gamma_j \boldsymbol{N}_j + \sum_k \phi_k \boldsymbol{E}_k + \varepsilon$$

- The net loss in property values from sea level rise in year *t* is estim ated by

$$Net\ \mathrm{Loss}_t = \delta \cdot \left\{ \boldsymbol{R}_{LOST,t} - A_{LOST,t} + \Delta \boldsymbol{R}_{INV,t} \right\}.$$

Current Property Values subject to SLR - New Hanover

	Property Values ($mil)	Lost Property Values for Various Sea Level Rise Scenarios					
		2030-Low	2030-Mid	2030-High	2080-Low	2080-Mid	2080-High
Total	$16,154.42	$80.36	$84.42	$88.87	$95.19	$123.01	$227.70
(n)*	85,786	495	516	544	574	680	1,063
(%)*		0.50%	0.52%	0.55%	0.59%	0.76%	1.41%
Residential	$11,688.36	$62.15	$66.20	$70.59	$72.85	$90.72	$167.40
(n)	74,984	345	360	385	403	476	773
(%)		0.53%	0.57%	0.60%	0.62%	0.78%	1.43%
Nonresidential	$4,466.06	$18.21	$18.21	$18.28	$22.34	$32.29	$60.31
(n)	10,802	150	156	159	171	204	290
(%)		0.41%	0.41%	0.41%	0.50%	0.72%	1.35%

Current Property Values subject to SLR - Dare

	Property Values ($mil)	Lost Property Values for Various Sea Level Rise Scenarios					
		2030-Low	2030-Mid	2030-High	2080-Low	2080-Mid	2080-High
Total	$18,800.01	$1,142.87	$1,241.80	$1,332.87	$1,623.00	$2,224.75	$3,544.75
(n)*	38,780	1,506	1,725	1,965	2,331	4,004	7,716
(%)*		6.08%	6.61%	7.09%	8.63%	11.83%	18.86%
Residential	$12,262.76	$365.99	$410.84	$461.92	$521.55	$906.67	$1,801.99
(n)	27,006	825	927	1,051	1,225	2,143	4,371
(%)		2.98%	3.35%	3.77%	4.25%	7.39%	14.69%
Nonresidential	$6,537.25	$776.88	$830.97	$870.95	$1,101.45	$1,318.07	$1,742.76
(n)	11,774	681	798	914	1,106	1,861	3,345
(%)		11.88%	12.71%	13.32%	16.85%	20.16%	26.66%

Current Property Values subject to SLR - Carteret

	Property Values ($mil)	Lost Property Values for Various Sea Level Rise Scenarios					
		2030-Low	2030-Mid	2030-High	2080-Low	2080-Mid	2080-High
Total	$8,217.34	$172.08	$176.38	$185.82	$202.38	$260.33	$433.40
(n)*	55,509	1,077	1,140	1,225	1,322	1,977	3,890
(%)*		2.09%	2.15%	2.26%	2.46%	3.17%	5.27%
Residential	$5,960.24	$42.83	$45.53	$49.41	$56.12	$92.29	$208.05
(n)	34,073	192	207	228	261	468	1,204
(%)		0.72%	0.76%	0.83%	0.94%	1.55%	3.49%
Nonresidential	$2,257.10	$129.25	$130.85	$136.41	$146.26	$168.05	$225.35
(n)	21,436	885	933	997	1,061	1,509	2,686
(%)		5.73%	5.80%	6.04%	6.48%	7.45%	9.98%

Current Property Values subject to SLR - Bertie

	Property Values ($mil)	Lost Property Values for Various Sea Level Rise Scenarios					
		2030-Low	2030-Mid	2030-High	2080-Low	2080-Mid	2080-High
Total	$1,001.18	$5.25	$6.06	$6.63	$6.75	$8.45	$12.57
(n)*	17,502	72	81	93	99	126	174
(%)*		0.52%	0.61%	0.66%	0.67%	0.84%	1.26%
Residential	$727.09	$3.22	$3.73	$3.92	$4.04	$4.99	$7.66
(n)	15,777	55	61	68	73	91	126
(%)		0.44%	0.51%	0.54%	0.56%	0.69%	1.05%
Nonresidential	$274.09	$2.03	$2.33	$2.71	$2.71	$3.46	$4.91
(n)	1,725	17	20	25	26	35	48
(%)		0.74%	0.85%	0.99%	0.99%	1.26%	1.79%

Residential Property Values at Risk (NHC)

Residential	Discount Rate							
	No Discounting		2%		5%		7%	
SLR Scenario	$ (millions)	%	$ (millions)	%	$ (millions)	%	$ (millions)	%
2030-Low	$61.82	0.35%	$36.94	0.21%	$17.39	0.10%	$10.64	0.06%
2030-Mid	$65.49	0.37%	$39.14	0.22%	$18.42	0.10%	$11.28	0.06%
2030-High	$69.72	0.39%	$41.66	0.23%	$19.61	0.11%	$12.00	0.07%
2080-Low	$151.56	0.41%	$90.57	0.24%	$42.62	0.11%	$26.10	0.07%
2080-Mid	$194.37	0.52%	$116.15	0.31%	$54.66	0.15%	$33.47	0.09%
2080-High	$354.14	0.96%	$211.63	0.57%	$99.60	0.27%	$60.98	0.16%

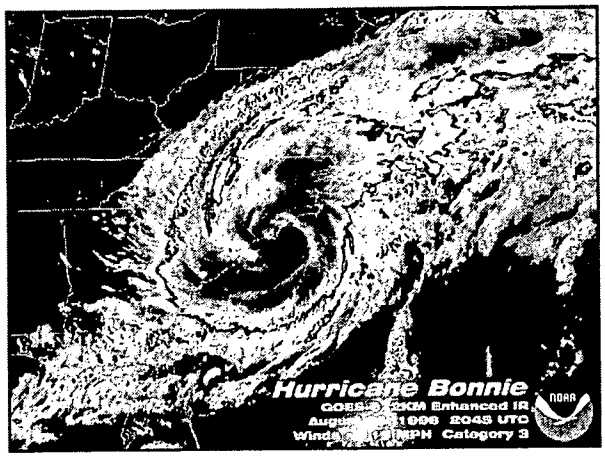
Summary

- We estimate the loss of property values due to sea level rise using a simulation approach based on hedonic property value models.
- The impacts of sea level rise on coastal property values vary across different portions of the North Carolina coastline.
- The northern part of the North Carolina coastline is comparatively more vulnerable to the effect of sea level rise than the southern part. The residential property value at risk in Dare County ranges from 1.3% to 6.9% of the total residential property value.

Summary

- The value of property at risk to sea-level rise in just four counties over the next 75 years is $6.9 billion.
- The present value of lost residential property value in 2080 is $3.2 billion discounted at a 2% rate.
- The present value of lost nonresidential property value in 2080 is $3.7 billion at a 2% rate.

Storm Impacts



Study Area



Changes in Hurricane Intensity

Hurricane categories for baseline and climate change scenarios

	Category 3 Hurricane (Hurricane Fran Track) Baseline Scenario	Climate Change Scenarios	
	1996	2030	2080
County	MAX	MAX	MAX
Bertie	TS	TS	TS
Carteret	1	2	2
Dare	TS	1	1
New Hanover	2	2	3

TS = tropical storm, 1 = category 1 hurricane, 2 = category 2 hurricane, etc.

Assume No Changes in Hurricane Frequency

Observed annual hurricane strike frequencies

Hurricane Category	1	2	3	4	5
Number of Strikes in North Carolina 1851-2006	23	13	11	1	0
Annual Frequency	0.1474	0.0833	0.0705	0.0064	0.0000

Full Business Day Equivalents Lost

Source: Burrus, Dumas, Farrell and Hall (Natural Hazards Review 2002)

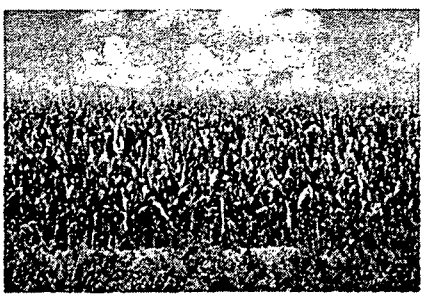
Industry Name	Bertha (Cat 1)	Bonnie (Cat 2)	Fran (Cat 3)
Boat Building and Repairing	6.54	32.21	104.46
Amusement and Recreation Services	9.94	17.78	89.03
Food Stores	12.92	27.08	23.25
New Residential Structures	12.96	6.33	34.25
Electrical Repair Service	1.00	4.00	42.50
Furniture & Home Furnishings Stores	8.58	4.92	31.58
Real Estate	10.74	8.24	11.72
Miscellaneous Retail	8.02	4.19	14.27
Banks	6.31	2.88	14.35
Radio and TV Broadcasting	2.00	8.75	12.38
Hotels and Lodging Places	0.83	0.60	21.35
Weighted Means Over ALL Sectors	3.75	4.66	12.61

Business Interruption Impacts

- Business interruption losses in just four NC counties
  - Dare, Bertie, Carteret, New Hanover
  - Allows industry mix to vary across counties
  - Does not include agriculture, forestry, or comm. fisheries
- Due to increases in category 3 hurricane severity ONLY
  - $34 million increase per storm by 2030
  - $157 million increase per storm by 2080
- Cumulative impact 2004-2080
  - $373 million assuming no pop or income growth
  - $1.44 billion assuming proj. state pop and per capita income growh

Impacts on Agriculture

- Based on historical NC Agri. Stats. Service data:
  - Cat 1 hurricane -- $50 million in agricultural damage
  - Cat 2 -- $200 million
  - Cat 3 -- $800 million.



- Increases in storm intensity, even for low-intensity hurricanes, could have serious impacts on agriculture.

Impacts on Forestry



- Less data available for forest sector.
- Based on historical NC Forest Service Timber Damage Assessment data:
  - Cat 2 hurricane (Isabel 2003) – $578 million statewide ($2004)
  - Cat 3 hurricane (Fran 1996) -- $1.496 billion statewide ($2004)
- Based on this limited data, an increase in storm severity from category 2 to category 3 can increase forest damage by $900 million.
  - Caveat: Fran may have "cleared out" weaker trees, leaving fewer trees for Isabel to damage. If so, incremental impacts of severity increases would be smaller.

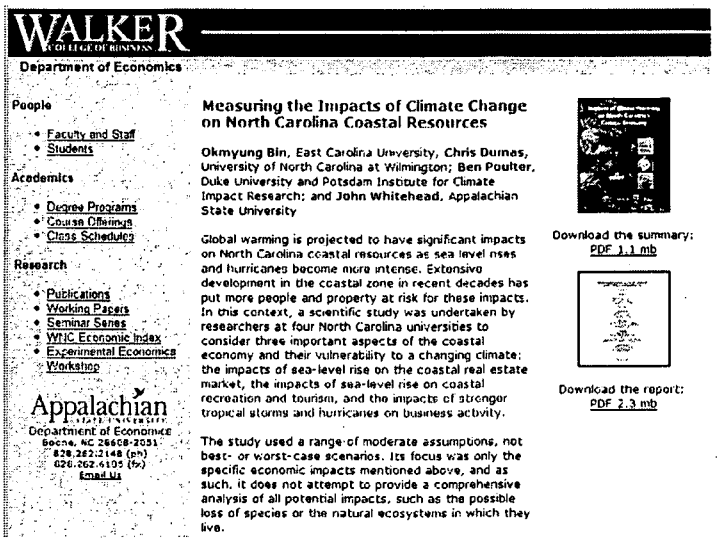
Potential Impacts of Climate Change on NC's Coastal Economy

- Potential Impacts over the next 75 years:
  - Lost recreational benefits total $3.9 billion
  - The value of property at risk to sea-level rise in just four counties is $6.9 billion
  - Business interruption, agriculture and forestry losses are also substantial
  - Assumes no increase in storm frequency – look forward to new results from climate and weather modelers that would allow us to update our impact estimates
- These are *potential* impacts, assuming no adaptation or mitigation.
- These results facilitate comparison of policy costs and benefits. *Avoiding these potential impacts is a measure of the benefits of adaptation and mitigation policies.*

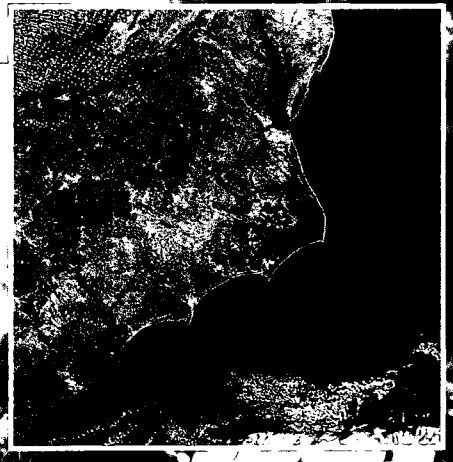
Additional Research Underway:

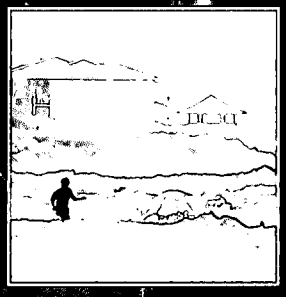
- UNC Research Competitiveness Fund has approved funding for additional research on "NC Coastal Hazards: Economic Implications of Severe Storms and Sea-Level Rise"
- $288K
- Joint work: ECU-lead (Steve Culver & Stan Riggs), WCU, ASU, UNCW, CSI.
- Report due this summer.

http://econ.appstate.edu/climate



Impacts of Global Warming on North Carolina's Coastal Economy









UNCW

Appalachian State University

East Carolina University

Duke University

IMPACTS OF GLOBAL WARMING ON NORTH CAROLINA'S COASTAL ECONOMY

Key Findings

Global warming is projected to have significant impacts on North Carolina coastal resources as sea level rises and hurricanes become more intense. Extensive development in the coastal zone in recent decades has put more people and property at risk for these impacts.

Global warming will result in

Sea-level rise

Billions in lost property values

Large losses in recreational benefits

Complete loss of many beaches

Hurricane intensity increases

Losses due to business interruptions

Increasing agricultural losses

Greater damage to forests

Increasing commercial fishing losses

In this context, a scientific study was undertaken by researchers at four North Carolina universities to consider three important aspects of the coastal economy and their vulnerability to a changing climate: the impacts of sea-level rise on the coastal real estate market, the impacts of sea-level rise on coastal recreation and tourism, and the impacts of stronger tropical storms and hurricanes on business activity.

The study used a range of moderate assumptions, not best- or worst-case scenarios. Its focus was only the specific economic impacts mentioned above, and as such, it does not attempt to provide a comprehensive analysis of all potential impacts, such as the possible loss of species or the natural ecosystems in which they live. This brief summary brochure is designed to present the main findings of the study in plain language for the benefit of the public and policy makers. The full technical report can be obtained at: http://econ.appstate.edu/climate/

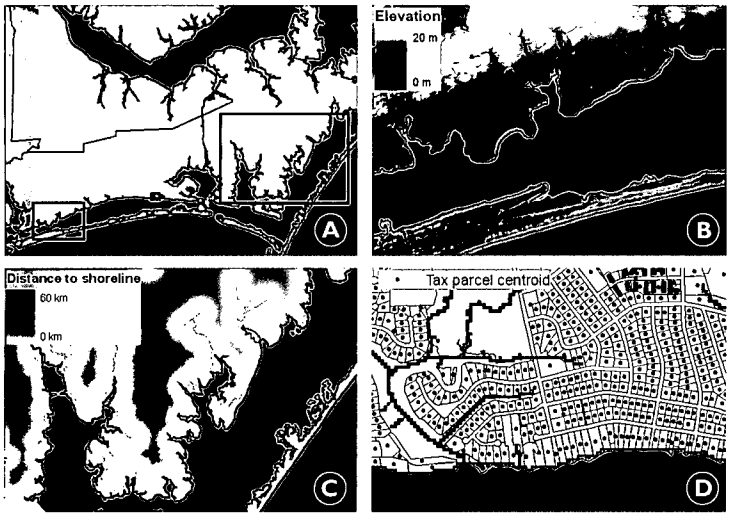


Property Losses

1. The value of property at risk to sea-level rise in just four counties over the next 75 years is $6.9 billion.

2. Projected losses in residential property values vary by county, with the northern counties comparatively more vulnerable than the southern. The property at risk in Dare County ranges from 2% to 12% of the total property value.

Property Value Data for Carteret County



Carteret County (a), lidar elevation surface (b), distance to shoreline (c), and tax parcel centriods (d).

New Hanover, Dare, Carteret, and Bertie Counties were chosen for this analysis because they represent a cross-section of the NC coast geographically and in terms of development. Three of these are also the three most populous counties on the NC coast.

Recreation and Tourism

3. The lost recreation value of climate change-induced sea-level rise to local beach goers is projected to be $93 million a year by 2030 and $223 million a year by 2080 for the southern North Carolina beaches.

4. Spending by non-local North Carolina residents on beach trips would fall significantly with warming-induced sea-level rise, dropping by 16% per year by 2030 and by 48% per year by 2080.

5. Reduced opportunities for beach trips and fishing trips are projected to result in lost recreational benefits totaling $3.9 billion for the southern North Carolina beaches over the next 75 years.

Only the southern NC counties of Brunswick, New Hanover, Pender, Onslow, and Carteret were considered in the beach recreation analysis, due to data limitations.

Projected Changes in Beach Width for the Southern NC Beaches

By 2080, 14 of the 17 recreational swimming beaches in southern NC are projected to have eroded all the way to the road, making beach recreation no longer possible.

Beach	Average width (in feet) in each year		
	2004	2030	2080
Fort Macon	90	40	0
Atlantic Beach	135	85	0
Pine Knoll Shores	110	60	0
Indian Beach/Salter Path	90	40	0
Emerald Isle	130	80	0
North Topsail Beach	82	32	0
Surf City	90	40	0
Topsail Beach	110	60	0
Wrightsville Beach	160	110	3
Carolina Beach	185	135	28
Kure Beach	130	80	0
Fort Fisher	400	350	243
Caswell Beach	80	30	0
Oak Island	120	70	0
Holden Beach	90	40	0
Ocean Isle Beach	85	35	0
Sunset Beach	115	65	0



This study was conducted by:

Okmyung Bin, Department of Economics, East Carolina University, Greenville, NC

Chris Dumas, Department of Economics and Finance, University of North Carolina at Wilmington

Ben Poulter, Duke University, Nicholas School of the Environment and Department of Global Change and Natural Systems, Potsdam Institute for Climate Impact Research, Germany

John Whitehead, Department of Economics, Appalachian State University, Boone, NC

For further information about the research, contact John Whitehead <whiteheadjc@appstate.edu> or Ben Poulter <ben.poulter@pik-potsdam.de>

This research was supported by a grant from the National Commission on Energy Policy.



Business, Agriculture, and Forests

6. Increased hurricane intensity will interrupt businesses, reducing economic output to varying degrees, depending on location and the severity of warming. Business interruption losses in just four NC counties due to increases in category 3 hurricane severity (excluding increases in all other categories) are projected to rise by $34 million per storm in 2030, and by $157 million per storm in 2080. Assuming no increase in hurricane frequency, the projected cumulative losses from 2004 to 2080 due to increased category 3 severity in these four counties amount to $1.44 billion.

7. Increasing storm intensity is expected to have serious impacts on agriculture. A category 1 hurricane now causes about $50 million in agricultural damage, a category 2, about $200 million, and a category 3, about $800 million, illustrating how significant an increase in hurricane intensity would be for this sector.

8. Increased forest damage associated with an increase in storm severity from category 2 to category 3 is about 150% per storm event, or about $900 million more in damages.



The four counties (New Hanover, Dare, Carteret, and Bertie Counties) selected for the hurricane intensity analysis represent a range of geographic location and urbanization intensity. Changes among low-intensity hurricane categories were identified as the most likely impacts of climate change on storm intensity. Although low-intensity storms cause less physical damage than do high-intensity storms, low-intensity storms occur with much greater frequency, especially in North Carolina; thus, their cumulative economic impacts can be very large.

Impacts of Increased Storm Severity on NC Timber Damage (2004 dollars)

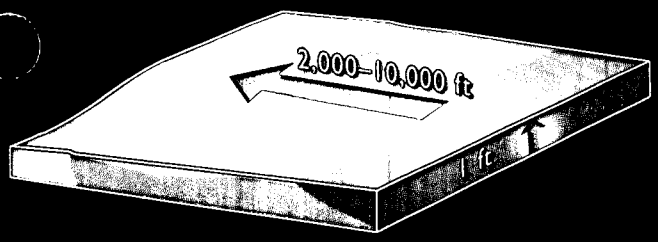
Hurricane Category	NC Statewide Forest Acres Damaged	NC Statewide Timber Damage Losses
2	0.8 million acres	$0.6 billion
3	8.3 million acres	$1.5 billion

Impacts of Increased Storm Severity on Agricultural Damages Per Hurricane, 1996–2006

Storm Category	NC Statewide Totals (2004 dollars)
Tropical Storm	$53,695
Category 1	$32,878
Category 2	$208,558,508
Category 3	$837,822,329

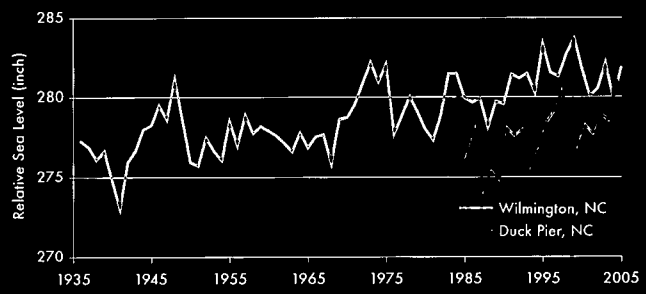
As hurricanes increase in intensity, average damages rise.

Sea-level Rise and Coastal Inundation



A one-foot rise in sea level can cause the inland movement of the shoreline by 2,000 to 10,000 feet when the land is as flat as the North Carolina coast.

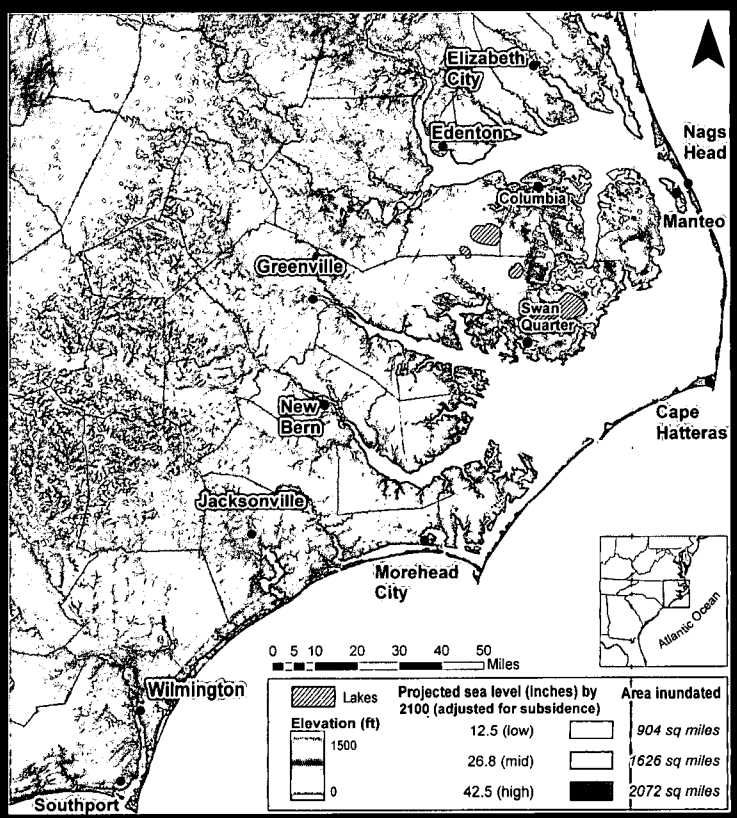
Observed Rates of Sea-level Rise along the North Carolina Coast



The North Carolina coast is particularly vulnerable to sea-level rise for several reasons: the land has very little slope, meaning that even small increases in sea level result in a wide expanse of coastal land being inundated and lost. In addition, while sea level is rising globally due to warming, the coastal land in this area is slowly sinking due to tectonic forces, so the relative sea-level rise is larger here than in places where the coastline is stable or rising. Thus the current rate of sea-level rise in this area is about twice the global average.

Global warming causes sea level to rise for several reasons. First, as water warms it expands, taking up more space. Second, as mountain glaciers around the world melt, this water flows to the oceans. And third, the two large polar ice sheets on Greenland and Antarctica are now melting, although how much and how fast they will melt is not well known. Thus current projections of future sea-level rise don't fully account for changes in the large ice sheets, and future sea-level rise could be greater than the assumptions used in this study.

Land in Red is at Risk of Loss Due to Sea-level Rise by 2100



The sea-level rise projections for this area range from about one to three feet within this century, with additional increases later.

Sea-level Rise

1-15-2008

Planned work products:
"North Carolina Coastal Hazards-Economic Implications of Severe Storms and Sea-Level Rise."
For more info, contact Steve Culver, ECU, 252-328-6360, culvers@ecu.edu

1) "North Carolina: A Coast in Crisis", a US Geological Survey Circular designed for the general public (manuscript to the press in March, 2008) (Riggs, Ames, Culver).

2) "In the Eye of a Hurricane: Pea Island and the Northern Outer Banks", in "America's Most Valuable Oceanfront Communities" (manuscript to the press in April, 2008) (Riggs and Ames).

3) The economic impact of sea-level rise on coastal real estate in Dare, Carteret, New Hanover and Bertie counties: web database and d technical report (Bin).

4) The economic impact to local economies of sea-level rise on marine recreational fishing: web database and technical report (Whitehead and Dumas).

5) The economic impact due to loss of access through inlet formation: technical report (Vogelsong).

6) An assessment of market demand for flood insurance in selected coastal counties: technical report (Landry and Jahan-Parvar).

7) The effects of urbanization on the hydrologic response to storm events; maps of urbanizing areas, public workshop at CSI (O'Driscoll, Allen and White).

8) A NC coastal hazard and human vulnerabilities database: design and prototype of database, GIS map of inlet vulnerability (Walsh, Corbett, Allen, Crawford).

9) A GIS database of coastal engineering structures and nourishment projects (Young).

10) A map of historic, prehistoric or undocumented inlets on the Outer Banks (Mallinson).

11) Geologic profiles of the Hwy 12 corridor (specifically relevant to the Bonner Bridge replacement) (Mallinson).

12) A series of educational lectures on various coastal issues of economic consequence (e.g., Bonner Bridge, Hwy 12, coastal erosion, sea-level rise, etc) to various agencies and organizations and the general public (Riggs and others).

e

ENVIRONMENTAL DEFENSE

finding the ways that work

NEWS RELEASE

FOR IMMEDIATE RELEASE

Contact:
Jerry Karnas, gkarnas@environmentaldefense.org, Environmental Defense, 941-587-1803
Dr. Frank Ackerman, Tufts University, 617-627-6957
Lisa Garcia, lgarcia@ronsachs.com, Ron Sachs Communications, 850-222-1996

Climate Change Poses Significant Threat to Key Economic Sectors in Florida

University Study Says Five Percent of State's Economy At Risk

(Tallahassee, FL– November 28, 2007) If left unchecked, climate change will significantly harm Florida's economy in the next several decades, according to a new report by Tufts University economists. Impacts on just three sectors – tourism, electric utilities and real estate – together with effects of hurricanes would shrink Florida's Gross State Product by 5% by the end of this century.

"The bad news is that unconstrained climate change will hit Florida's economy hard," said Dr. Frank Ackerman of Tuft's University's Global Development and Environmental Institute and Stockholm Environment Institute-US, one of the report's lead authors. "But the good news is that these impacts can largely be avoided by taking action in the near future to rapidly stabilize overall emissions of the greenhouse gas emissions that cause climate change."

"Florida and Climate Change: The Costs of Inaction," commissioned by Environmental Defense, is the first detailed analysis on the potential consequences of continued climate change for the state's economy. The report compares two specific climate scenarios: a pessimistic *business-as-usual case* and a *rapid stabilization case.*

"These scenarios represent what will happen if the world succeeds in a robust program of climate mitigation, versus what will happen if we do very little. Our analysis focuses on direct economic impacts, and doesn't even begin to reflect the human and environmental impacts that would also result – impacts that may well outstrip the dollar costs," said Ackerman.

Under the business-as-usual scenario, sea-level rise is projected to reach 23 inches by 2050, and 45 inches by 2100. Almost one-tenth of Florida's current population, or 1.5 million people, lives in the vulnerable zone that would be inundated. Tourism, one of Florida's largest economic sectors, will be the hardest hit as much of the state's wealth of natural beauty – sandy beaches, the Everglades and the Keys – disappears under the waves. The vulnerable zone also includes key infrastructure, including two nuclear power plants, three prisons, 68 hospitals, 74 airports, 334 public schools and nearly 20,000 historic structures.

"Arguments against strong action to combat climate change often implicitly assume that inaction would be cost-free — that we can choose a future without significant impacts from climate change even if emissions of carbon dioxide and other greenhouse gases continue to grow

unchecked," said Ackerman. "But the overwhelming scientific consensus now holds that this rosy assumption is simply wrong, and that the more greenhouse gases are released, the worse the consequences will be."

"This study shows that Florida stands to lose big time if Congress fails to enact strong climate legislation in the near future," said Gerald Karnas, Florida Climate Project Director for Environmental Defense. "The longer Congress delays, the harder that climate change will hit Floridians right in the wallet."

###

Environmental Defense, a leading national nonprofit organization, represents more than 500,000 members. Since 1967, Environmental Defense has linked science, economics, law and innovative private-sector partnerships to create breakthrough solutions to the most serious environmental problems. www.environmentaldefense.org

Florida and Climate Change
The costs of inaction

Dr. Frank Ackerman
Tufts University
November 28, 2007

The message in brief

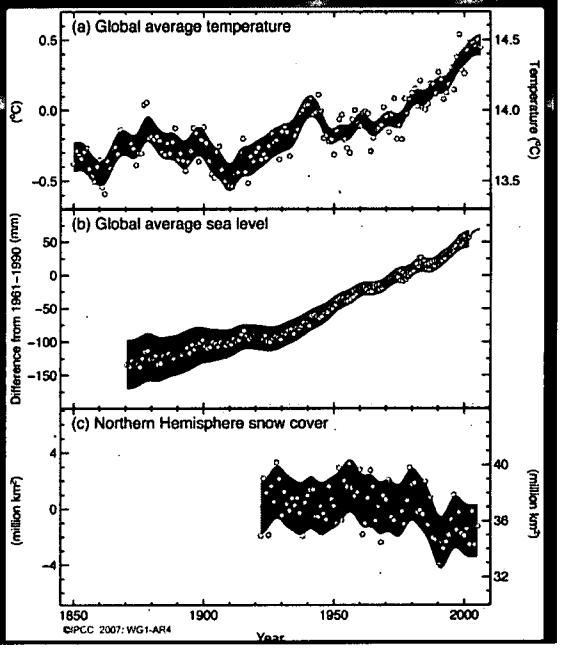
- Doing something about climate change may seem expensive, *but…*
  - Doing **nothing** about climate change will be **REALLY** expensive
  - Four effects of inaction will amount to **5% of Florida state income by 2100**
- Other critical impacts of climate change cannot be priced

The latest evidence (IPCC, 2007)

The world is getting hotter

Sea levels are rising

Snow cover is decreasing
(Northern Hemisphere, March-April)

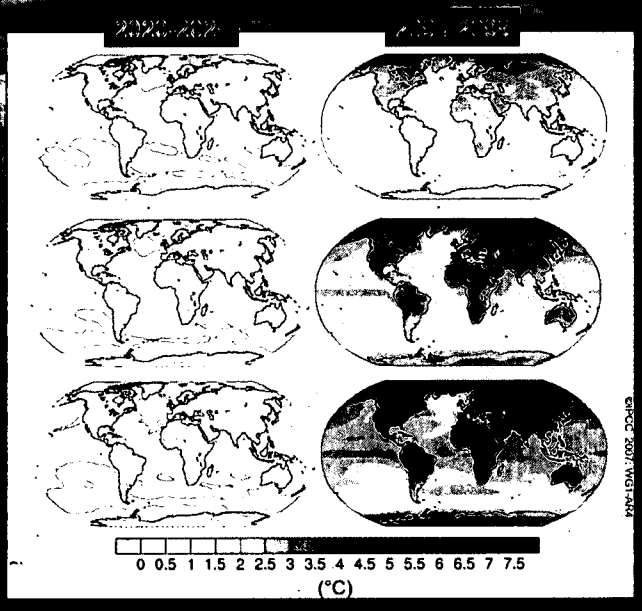


Temperature change *(relative to 1980-99)*

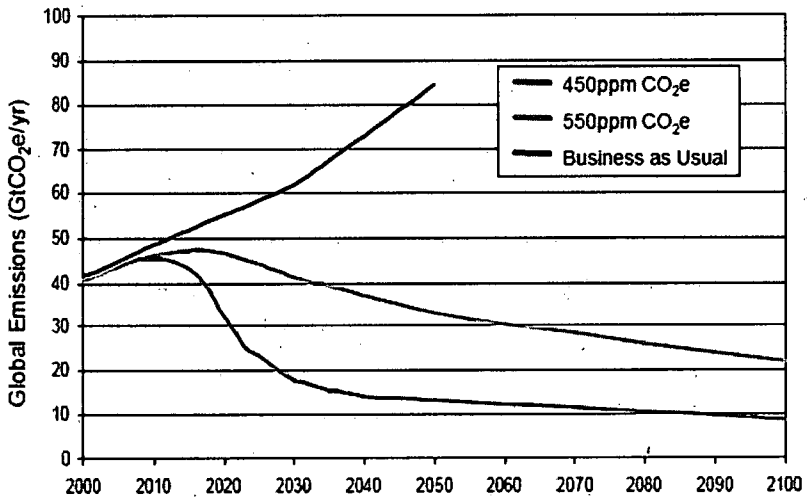
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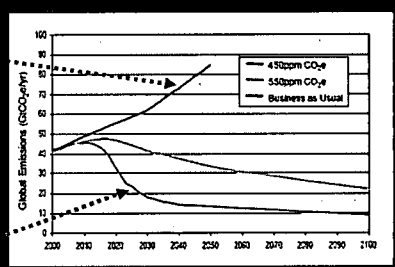


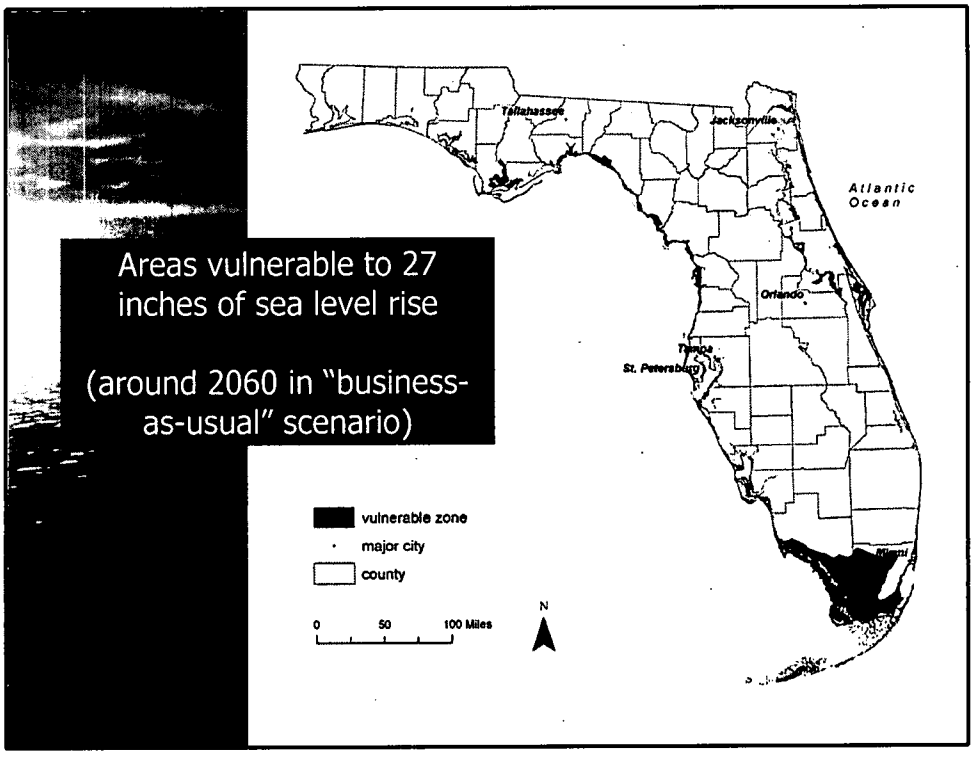
Emissions Paths to Stabilization



Two scenarios for Florida's climate

- Business as usual
  - CO_2 emissions continue rising
  - 10°F temperature increase
  - 45 inches sea level rise
  - 10% less rainfall
  - More intense hurricanes
- Rapid stabilization
  - Success in meeting state emission targets, comparable reductions nationwide, worldwide
  - 2°F temperature change, 7 inches sea level rise
  - No change in hurricanes, rainfall





What's vulnerable to 27 inches of sea level rise?

2 nuclear reactors;

3 prisons;

37 nursing homes;

68 hospitals;

74 airports;

82 low-income housing complexes;

115 solid waste disposal sites;

140 water treatment facilities;

171 assisted livings facilities;

247 gas stations;

277 shopping centers;

334 public schools;

341 hazardous-material cleanup sites, including 5 Superfund sites;

1,025 churches, synagogues, and mosques;

1,362 hotels, motels, and inns; and

19,684 historic structures.

...and 99% of Monroe County, 2/3 of Miami-Dade, and 10% - 20% of many other coastal counties

Impacts, 1: Tourism

- 10% of the Florida economy depends on tourism
  - Hotter, stormier weather, loss of beaches to sea level rise will decrease tourism
- Slowest season today is autumn
  - ¾ of annual average level of tourism
- Business-as-usual losses
  - Tourism declines to ¾ of current share of state economy, year-round, by 2100
- Loss = $167 billion, or 2.4% of state income by 2100

Impacts, 2: Sea level rise

- Two scenarios for sea level rise
  - Rapid stabilization: 7 inches by 2100
  - Business as usual: 45 inches by 2100
- Increase in residential property at risk
  - Proportional to sea level rise, state income
  - $10 billion (rapid stabilization) vs. $66 billion (business as usual) per year by 2100
- Difference = $56 billion, or 0.8% of state income by 2100

Impacts, 3: Hurricane intensity

- Rapid stabilization: no change from today
  - Damages proportional to income, population
  - $55 billion losses, 20 deaths annually by 2100
- Business as usual: more Category 4, 5 hurricanes
  - Same number but increased *intensity* of storms
  - $159 billion losses, 57 deaths annually by 2100
- Difference = $104 billion, or 1.5% of state income and 37 more deaths a year by 2100

Impacts, 4: Electricity costs

- Rapid growth in electric system needed to serve growing population, economy
  - Many new power plants in rapid stabilization scenario; even more in business as usual
- Effects of higher temperatures
  - More electricity needed for air conditioning
  - Power plants are less efficient, and need more cooling water, when it's hotter
  - Transmission lines become overburdened
- Increased costs for business as usual: $18 billion, or 0.3% of state income by 2100

Other impacts on Florida's economy

- Water and agriculture: worsening crisis
  - Hotter, drier conditions will increase demand for water, and decrease fresh water supply
    - Desalination is expensive, requires more electricity
  - Agriculture will need more irrigation water – which is simply not available
- Insurance industry will continue to desert the state as hurricane risks worsen
- Fragile ecosystems in Everglades, Keys, other coastal areas will face irreversible damages

Conclusion: the high price of inaction

- Doing nothing about climate change is the expensive, short-sighted choice
- Costs in just four areas reach $345 billion annually – 5% of Florida state income – by 2100
- Florida, the nation, and the world have to stick to the current emission reduction targets
- Get it right, and your grandchildren will thank you for leaving them a liveable world

When It Rains, It Pours

Global Warming and the Rising Frequency of Extreme Precipitation in the United States

Presented to the North Carolina Legislative Commission on Global Climate Change

January 16, 2008

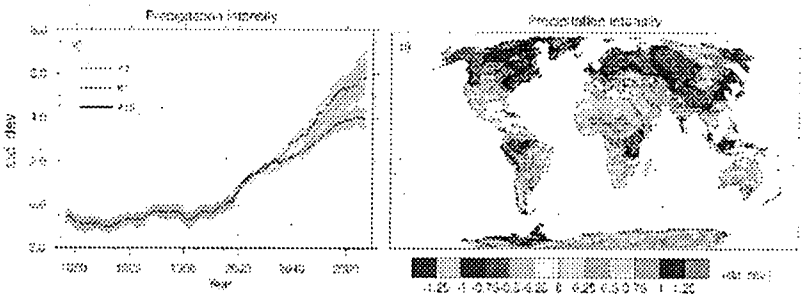
Travis Madsen, Policy Analyst
Frontier Group & Environment North Carolina

How Will Global Warming Affect Precipitation Patterns?

- More Intense Precipitation
  - More downpours; and
  - Extended periods of dry weather
- Slight Increase in Total Precipitation
- But, Increased Drought

More Intense Precipitation

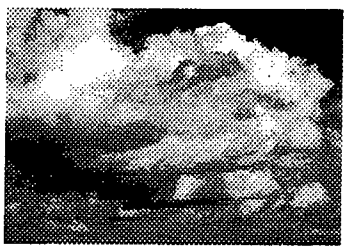
- When it rains, more rain is likely to fall.



Source: IPCC, "Global Climate Projections," *Climate Change 2007.*

The Explanation:

- Warmer temperatures lead to greater evaporation.
- Warmer air can hold more water vapor.
  - These factors enable clouds to become richer with moisture.

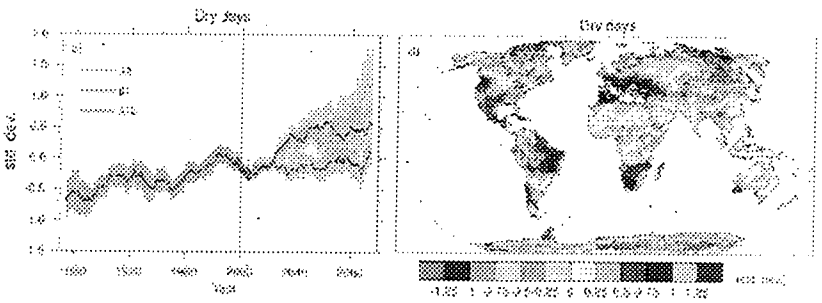


Changes in Overall Precipitation

- Overall, global warming is expected to slightly increase total annual rainfall across much of the United States.
- Summers will tend to be drier and winters, wetter.

Increased Drought

- At the same time, global warming is expected to cause extended periods of dry weather.

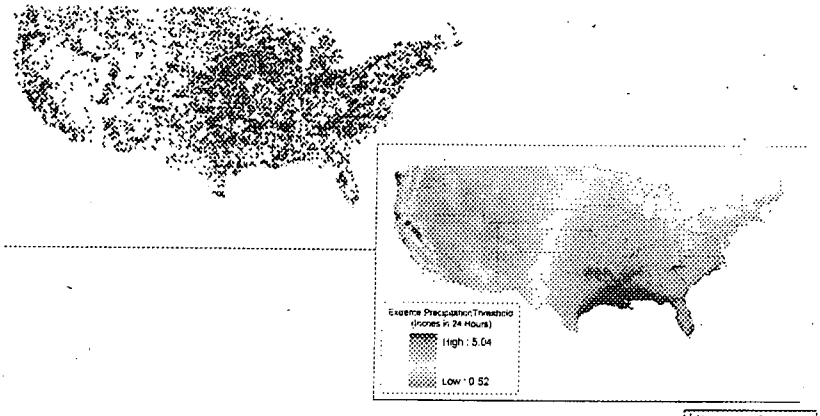


Source: IPCC, "Global Climate Projections," *Climate Change 2007*.

Methodology: In Brief

- We looked at daily precipitation records from more than 3,000 weather stations, identifying the largest storms.
- We then examined trends in the frequency of these storms over time, at each weather station.

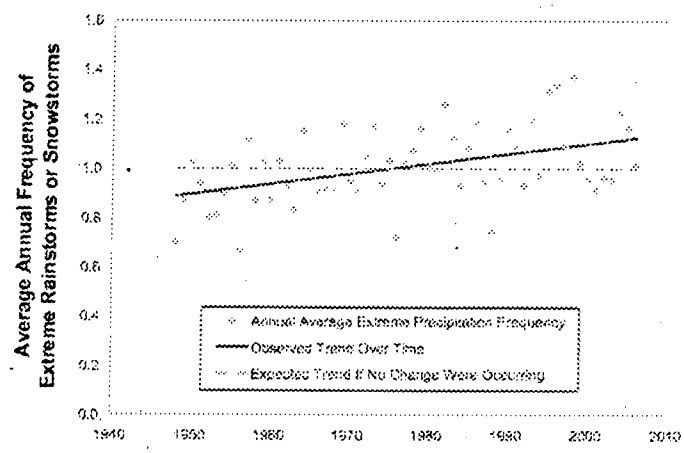
Methodology: In Brief



Extreme Precipitation Has Increased in Frequency

- Storms with extreme precipitation have increased in frequency by 24 percent across the continental U.S. since 1948.
- With 95 percent confidence from statistical analysis, the increase ranged between 22 to 26 percent.

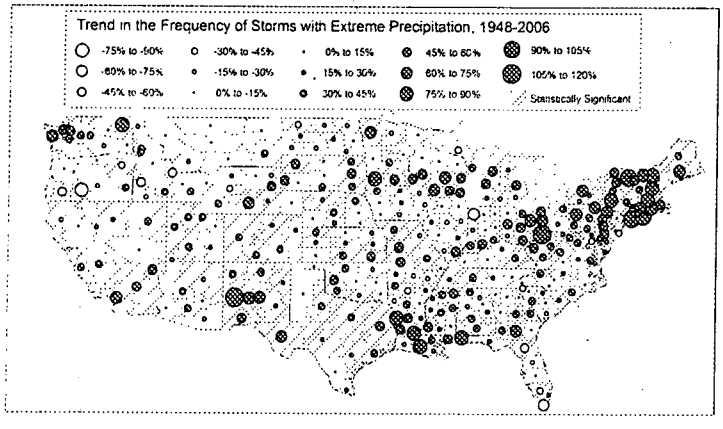
Extreme Precipitation Has Increased in Frequency



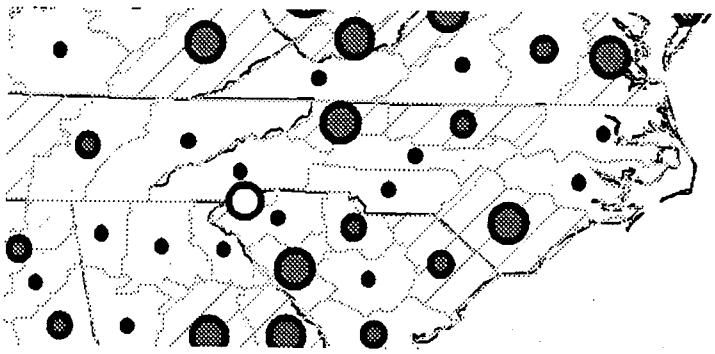
Extreme Precipitation Has Increased in Frequency

- In the South Atlantic, extreme precipitation increased in frequency by 15 percent (10 to 20 percent).
- In North Carolina, extreme storms became 16 percent more frequent (6 to 26 percent).

Extreme Precipitation Has Increased in Frequency



Extreme Precipitation Has Increased in Frequency



These Results Agree with Previous Research

- Other researchers have also documented this trend, observing in recent decades:
  - warmer weather,
  - higher atmospheric water content,
  - increased formation of storm clouds,
  - increased thunderstorm activity, and
  - trends toward increasingly frequent extreme precipitation in locations across the world, from subtropical Brazil to Siberia.

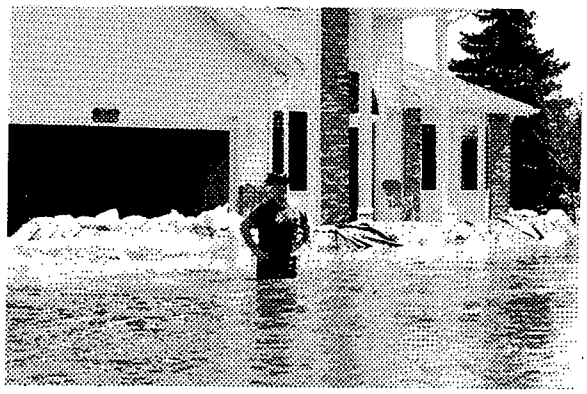
Links Between Observed Trends and Global Warming

- Scientists have documented human fingerprints in:
  - Increasing levels of carbon dioxide in the air;
  - Increasing global average temperature;
  - Changing temperature extremes;
  - Widespread melting of snow and ice;
  - Rising global sea level;
  - Altered wind patterns;
  - Increasing moisture content of the atmosphere over the oceans;
  - Increasing annual precipitation totals in temperate regions of the Northern Hemisphere
- Evidence is growing that increasingly intense precipitation is also linked to global warming.

Implications of More Intense Precipitation

- Flooding
  - Runoff Pollution and Sewage Overflows
  - Spread of Disease
  - Agricultural Damage
- Increased Drought

Flooding



Runoff, Sewage Overflows, Disease

- Risk of water pollution;
- Design criteria for runoff control may need to be changed;
- Increased risk of sewage discharge and spread of waterborne disease.

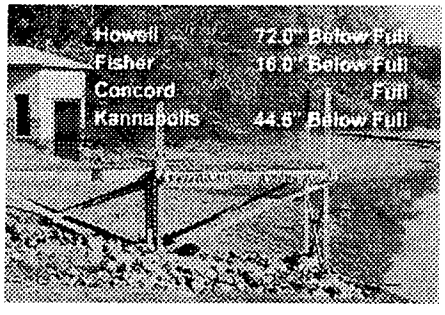
Agricultural Damage



After a storm in July 2006, the Lucas Farm lost about 300 acres of corn and green beans.
Source: PA Department of Agriculture.

Drought

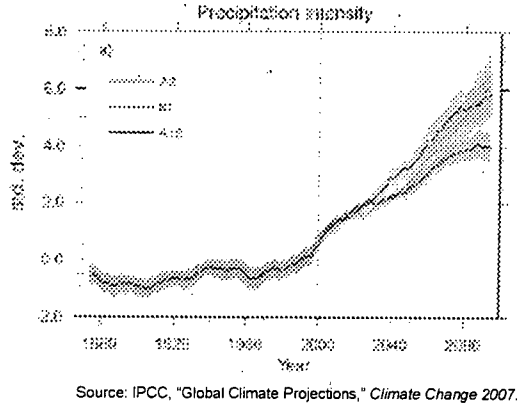
- Brought on by extended periods of dry weather;
- Aggravated by increased evaporation



Conclusions

- Global warming is already changing weather patterns in visible ways.
- Climate models predict that the trend toward increasingly frequent downpours will intensify in the future.
- At the same time, the number of dry days will also increase, making drought more likely.
- However, the severity of the trend depends upon our emissions of the pollution that drives global warming.

The Severity of the Trend Depends on Our Actions



Source: IPCC, "Global Climate Projections," *Climate Change 2007.*

Policy Recommendations

- Establish mandatory limits on global warming pollution;
- Auction 100 percent of emission allowances under any cap-and-trade program;
- Adopt policies to improve energy efficiency and increase the use of clean, renewable energy.

Thank You!

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Intergovernmental Panel on Climate Change
Fourth Assessment Report

Climate Change 2007: Synthesis Report

Summary for Policymakers

NOTE: Un-edited copy prepared for COP-13. The entire report is subject to final copy-edit prior to its final publication.

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References in curly brackets { } in this Summary for Policymakers refer to sections, tables and figures in the longer report of this Synthesis Report.

Introduction

This Synthesis Report is based on the assessment carried out by the three Working Groups of the IPCC. It provides an integrated view of climate change as the final part of the IPCC's Fourth Assessment Report.

A complete elaboration of the Topics covered in this summary can be found in this Synthesis Report and in the underlying reports of the three Working Groups.

1. Observed changes in climate and their effects

Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level (Figure SPM.1). {1.1}

Eleven of the last twelve years (1995-2006) rank among the twelve warmest years in the instrumental record of global surface temperature (since 1850). The 100-year linear trend (1906-2005) of 0.74 [0.56 to 0.92]°C [1] is larger than the corresponding trend of 0.6 [0.4 to 0.8]°C (1901-2000) given in the Third Assessment Report (TAR) (Figure SPM.1). The temperature increase is widespread over the globe, and is greater at higher northern latitudes. Land regions have warmed faster than the oceans (Figures SPM.2, SPM.4). {1.1, 1.2}

Rising sea level is consistent with warming (Figure SPM.1). Global average sea level has risen since 1961 at an average rate of 1.8 [1.3 to 2.3]mm/yr and since 1993 at 3.1 [2.4 to 3.8]mm/yr, with contributions from thermal expansion, melting glaciers and ice caps, and the polar ice sheets. Whether the faster rate for 1993 to 2003 reflects decadal variation or an increase in the longer-term trend is unclear. {1.1}

Observed decreases in snow and ice extent are also consistent with warming (Figure SPM.1). Satellite data since 1978 show that annual average Arctic sea ice extent has shrunk by 2.7 [2.1 to 3.3]% per decade, with larger decreases in summer of 7.4 [5.0 to 9.8]% per decade. Mountain glaciers and snow cover on average have declined in both hemispheres. {1.1}

From 1900 to 2005, precipitation increased significantly in eastern parts of North and South America, northern Europe and northern and central Asia but declined in the Sahel, the Mediterranean, southern Africa and parts of southern Asia. Globally, the area affected by drought has *likely*[2] increased since the 1970s. {1.1}

It is *very likely* that over the past 50 years: cold days, cold nights and frosts have become less frequent over most land areas, and hot days and hot nights have become more frequent. It is *likely* that: heat waves have become more frequent over most land areas, the frequency of heavy precipitation events has increased over most areas, and since 1975 the incidence of extreme high sea level[3] has increased worldwide. {1.1}

There is observational evidence of an increase in intense tropical cyclone activity in the North Atlantic since about 1970, with limited evidence of increases elsewhere. There is no clear trend in the annual numbers of tropical cyclones. It is difficult to ascertain longer-term trends in cyclone activity, particularly prior to 1970. {1.1}

Average Northern Hemisphere temperatures during the second half of the 20th century were *very likely* higher than during any other 50-year period in the last 500 years and *likely* the highest in at least the past 1300 years. {1.1}

[1] Numbers in square brackets indicate a 90% uncertainty interval around a best estimate, i.e. there is an estimated 5% likelihood that the value could be above the range given in square brackets and 5% likelihood that the value could be below that range. Uncertainty intervals are not necessarily symmetric around the corresponding best estimate.

[2] Words in italics represent calibrated expressions of uncertainty and confidence. Relevant terms are explained in the Box 'Treatment of uncertainty' in the Introduction of this Synthesis Report.

[3] Excluding tsunamis, which are not due to climate change. Extreme high sea level depends on average sea level and on regional weather systems. It is defined here as the highest 1% of hourly values of observed sea level at a station for a given reference period.

Changes in temperature, sea level and Northern Hemisphere snow cover

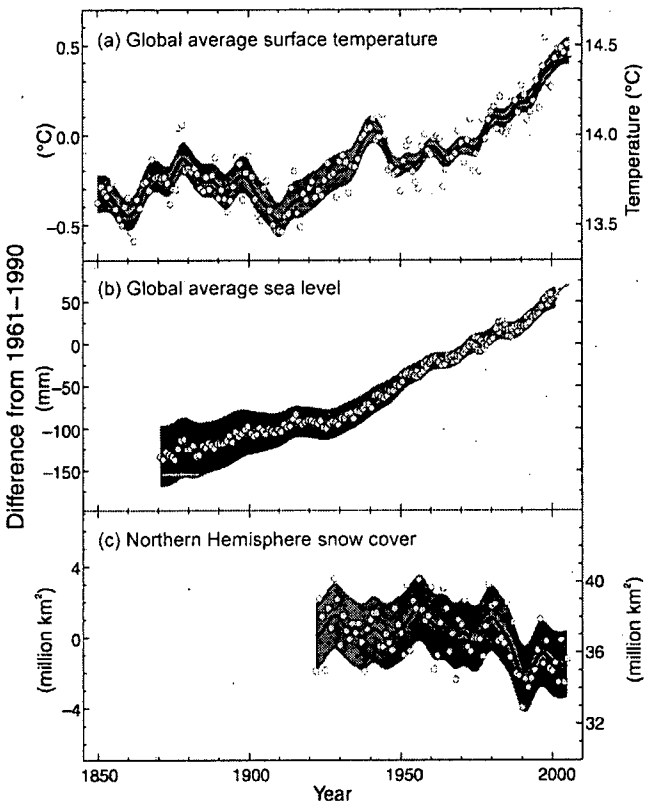


Figure SPM.1. Observed changes in (a) global average surface temperature; (b) global average sea level from tide gauge (blue) and satellite (red) data and (c) Northern Hemisphere snow cover for March-April. All differences are relative to corresponding averages for the period 1961-1990. Smoothed curves represent decadal averaged values while circles show yearly values. The shaded areas are the uncertainty intervals estimated from a comprehensive analysis of known uncertainties (a and b) and from the time series (c). {Figure 1.1}

Observational evidence[4] from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature increases. {1.2}

Changes in snow, ice and frozen ground have with *high confidence* increased the number and size of glacial lakes, increased ground instability in mountain and other permafrost regions, and led to changes in some Arctic and Antarctic ecosystems. {1.2}

There is *high confidence* that some hydrological systems have also been affected through increased runoff and earlier spring peak discharge in many glacier- and snow-fed rivers, and effects on thermal structure and water quality of warming rivers and lakes. {1.2}

In terrestrial ecosystems, earlier timing of spring events and poleward and upward shifts in plant and animal ranges are with *very high confidence* linked to recent warming. In some marine and freshwater systems, shifts in ranges and changes in algal, plankton and fish abundance are with *high confidence* associated with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels and circulation. {1.2}

[4] Based largely on data sets that cover the period since 1970.

Of the more than 29,000 observational data series, from 75 studies, that show significant change in many physical and biological systems, more than 89% are consistent with the direction of change expected as a response to warming (Figure SPM.2). However, there is a notable lack of geographic balance in data and literature on observed changes, with marked scarcity in developing countries. {1.2, 1.3}

Changes in physical and biological systems and surface temperature 1970-2004

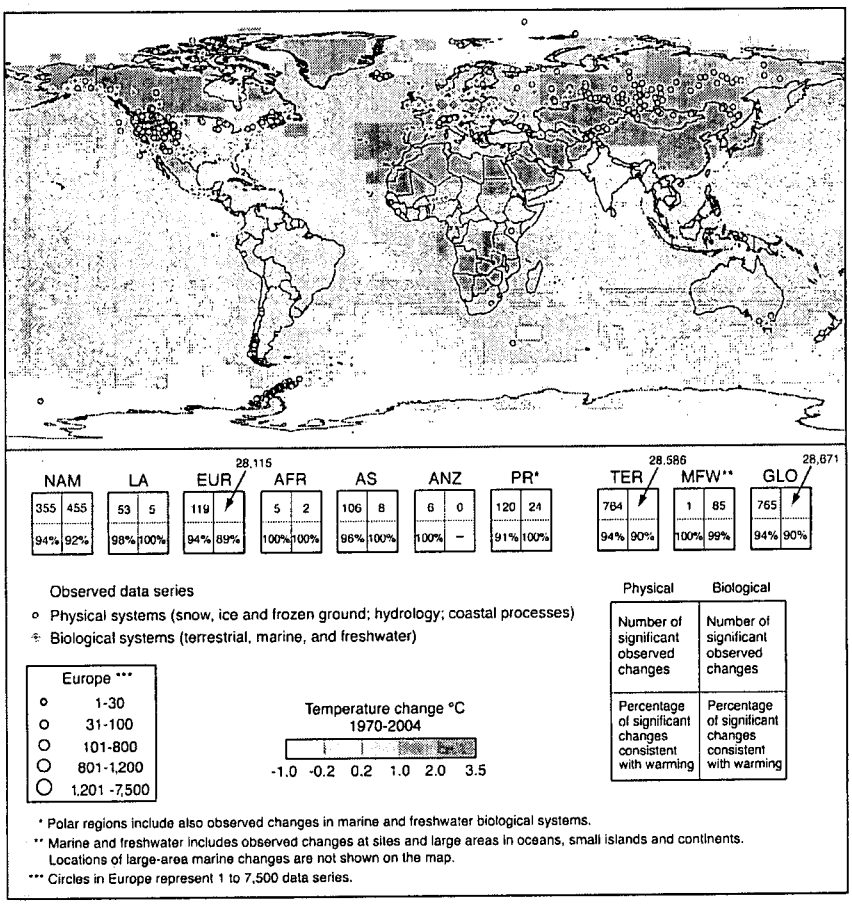


Figure SPM.2. Locations of significant changes in data series of physical systems (snow, ice and frozen ground; hydrology; and coastal processes) and biological systems (terrestrial, marine, and freshwater biological systems), are shown together with surface air temperature changes over the period 1970-2004. A subset of about 29,000 data series was selected from about 80,000 data series from 577 studies. These met the following criteria: (1) ending in 1990 or later; (2) spanning a period of at least 20 years; and (3) showing a significant change in either direction, as assessed in individual studies. These data series are from about 75 studies (of which about 70 are new since the Third Assessment) and contain about 29,000 data series, of which about 28,000 are from European studies. White areas do not contain sufficient observational climate data to estimate a temperature trend. The 2 x 2 boxes show the total number of data series with significant changes (top row) and the percentage of those consistent with warming (bottom row) for (i) continental regions: North America (NAM), Latin America (LA), Europe (EUR), Africa (AFR), Asia (AS), Australia and New Zealand (ANZ), and Polar Regions (PR) and (ii) global-scale: Terrestrial (TER), Marine and Freshwater (MFW), and Global (GLO). The numbers of studies from the seven regional boxes (NAM, EUR, AFR, AS, ANZ, PR) do not add up to the global (GLO) totals because numbers from regions except Polar do not include the numbers related to Marine and Freshwater (MFW) systems. Locations of large-area marine changes are not shown on the map. {Figure 1.2}

There is *medium confidence* that other effects of regional climate change on natural and human environments are emerging, although many are difficult to discern due to adaptation and non-climatic drivers.

They include effects of temperature increases on: {1.2}

- agricultural and forestry management at Northern Hemisphere higher latitudes, such as earlier spring planting of crops, and alterations in disturbance regimes of forests due to fires and pests

- some aspects of human health, such as heat-related mortality in Europe, changes in infectious disease vectors in some areas, and allergenic pollen in Northern Hemisphere high and mid-latitudes
- some human activities in the Arctic (e.g. hunting and travel over snow and ice) and in lower-elevation alpine areas (such as mountain sports).

2. Causes of change

Changes in atmospheric concentrations of greenhouse gases (GHGs) and aerosols, land-cover and solar radiation alter the energy balance of the climate system.

Global GHG emissions due to human activities have grown since pre-industrial times, with an increase of 70% between 1970 and 2004 (Figure SPM.3).[5] {2.1}

Carbon dioxide (CO_2) is the most important anthropogenic GHG. Its annual emissions grew by about 80% between 1970 and 2004. The long-term trend of declining CO_2 emissions per unit of energy supplied reversed after 2000. {2.1}

Global anthropogenic GHG emissions

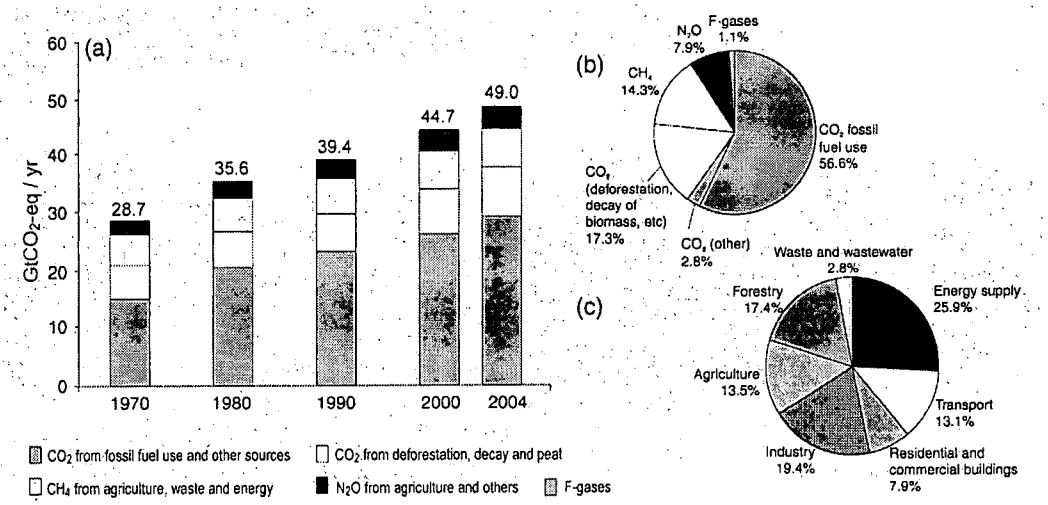


Figure SPM.3. (a) Global annual emissions of anthropogenic GHGs from 1970 to 2004.[5] (b) Share of different anthropogenic GHGs in total emissions in 2004 in terms of CO_2-eq. (c) Share of different sectors in total anthropogenic GHG emissions in 2004 in terms of CO_2-eq. (Forestry includes deforestation). {Figure 2.1}

Global atmospheric concentrations of CO_2, methane (CH_4) and nitrous oxide (N_2O) have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values determined from ice cores spanning many thousands of years. {2.2}

Atmospheric concentrations of CO_2 (379ppm) and CH_4 (1774 ppb) in 2005 exceed by far the natural range over the last 650,000 years. Global increases in CO_2 concentrations are due primarily to fossil fuel use, with land-use change providing another significant but smaller contribution. It is *very likely* that the observed increase in CH_4 concentration is predominantly due to agriculture and fossil fuel use. Methane growth rates have declined since the early 1990s, consistent with total emissions (sum of anthropogenic and natural sources) being nearly constant during this period. The increase in N_2O concentration is primarily due to agriculture. {2.2}

There is *very high confidence* that the net effect of human activities since 1750 has been one of warming.[6] {2.2}

[5] Includes only CO_2, CH_4, N_2O, HFCs, PFCs and SF_6 whose emissions are covered by the UNFCCC. These GHGs are weighted by their 100-year Global Warming Potentials, using values consistent with reporting under the UNFCCC.

[6] Increases in GHGs tend to warm the surface while the net effect of increases in aerosols tends to cool it. The net effect due to human activities since the pre-industrial era is one of warming (+1.6 [+0.6 to +2.4]W/m^2). In comparison, changes in solar irradiance are estimated to have caused a small warming effect (+0.12 [+0.06 to +0.30]W/m^2).

Most of the observed increase in globally-averaged temperatures since the mid-20th century is *very likely* due to the observed increase in anthropogenic GHG concentrations.[7] It is *likely* there has been significant anthropogenic warming over the past 50 years averaged over each continent (except Antarctica) (Figure SPM.4). {2.4}

During the past 50 years, the sum of solar and volcanic forcings would *likely* have produced cooling. Observed patterns of warming and their changes are simulated only by models that include anthropogenic forcings. Difficulties remain in simulating and attributing observed temperature changes at smaller than continental scales. {2.4}

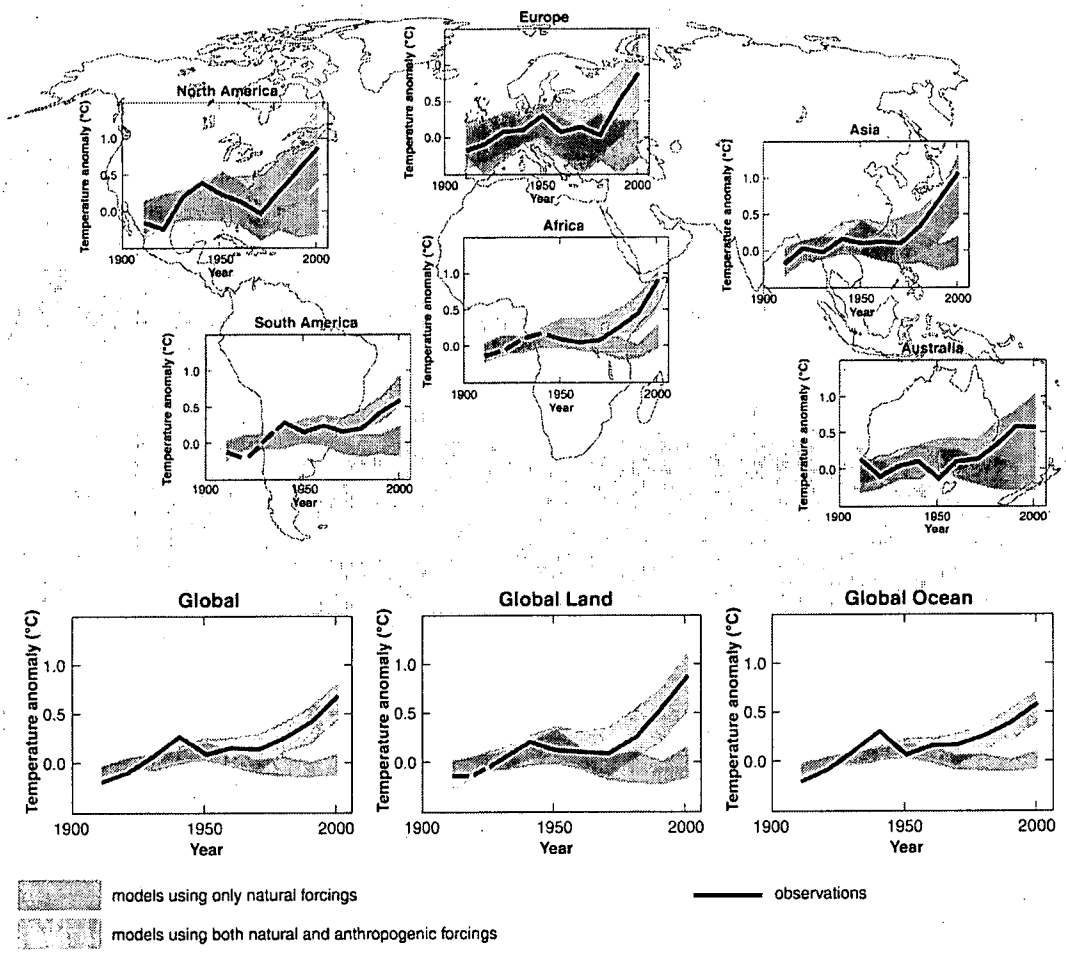


Figure SPM.4. Comparison of observed continental- and global-scale changes in surface temperature with results simulated by climate models using either natural or both natural and anthropogenic forcings. Decadal averages of observations are shown for the period 1906-2005 (black line) plotted against the centre of the decade and relative to the corresponding average for the period 1901-1950. Lines are dashed where spatial coverage is less than 50%. Blue shaded bands show the 5-95% range for 19 simulations from 5 climate models using only the natural forcings due to solar activity and volcanoes. Red shaded bands show the 5-95% range for 58 simulations from 14 climate models using both natural and anthropogenic forcings. {Figure 2.5}

[7] Consideration of remaining uncertainty is based on current methodologies.

Advances since the TAR show that discernible human influences extend beyond average temperature to other aspects of climate. {2.4}

Human influences have: {2.4}

- *very likely* contributed to sea level rise during the latter half of the 20th century
- *likely* contributed to changes in wind patterns, affecting extra-tropical storm tracks and temperature patterns
- *likely* increased temperatures of extreme hot nights, cold nights and cold days
- *more likely than not* increased risk of heat waves, area affected by drought since the 1970s and frequency of heavy precipitation events.

Anthropogenic warming over the last three decades has *likely* had a discernible influence at the global scale on observed changes in many physical and biological systems. {2.4}

Spatial agreement between regions of significant warming across the globe and locations of significant observed changes in many systems consistent with warming is *very unlikely* to be due solely to natural variability. Several modelling studies have linked some specific responses in physical and biological systems to anthropogenic warming. {2.4}

More complete attribution of observed natural system responses to anthropogenic warming is currently prevented by the short time scales of many impact studies, greater natural climate variability at regional scales, contributions of non-climate factors and limited spatial coverage of studies. {2.4}

3. Projected climate change and its impacts

There is *high agreement* and *much evidence* that with current climate change mitigation policies and related sustainable development practices, global GHG emissions will continue to grow over the next few decades. {3.1}

The IPCC Special Report on Emission Scenarios (SRES, 2000) projects an increase of global GHG emissions by 25-90% (CO_2-eq) between 2000 and 2030 (Figure SPM.5), with fossil fuels maintaining their dominant position in the global energy mix to 2030 and beyond. More recent scenarios without additional emissions mitigation are comparable in range. [8, 9] {3.1}

Continued GHG emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would *very likely* be larger than those observed during the 20th century (Table SPM.1, Figure SPM.5). {3.2.1}

For the next two decades a warming of about 0.2°C per decade is projected for a range of SRES emission scenarios. Even if the concentrations of all GHGs and aerosols had been kept constant at year 2000 levels, a further warming of about 0.1°C per decade would be expected. Afterwards, temperature projections increasingly depend on specific emission scenarios. {3.2}

[8] For an explanation of SRES emission scenarios, see Box 'SRES scenarios' in Topic 3 of this Synthesis Report. These scenarios do not include additional climate policy above current ones; more recent studies differ with respect to UNFCCC and Kyoto Protocol inclusion.

[9] Emission pathways of mitigation scenarios are discussed in Section 5.

Scenarios for GHG emissions from 2000 to 2100 (in the absence of additional climate policies) and projections of surface temperatures

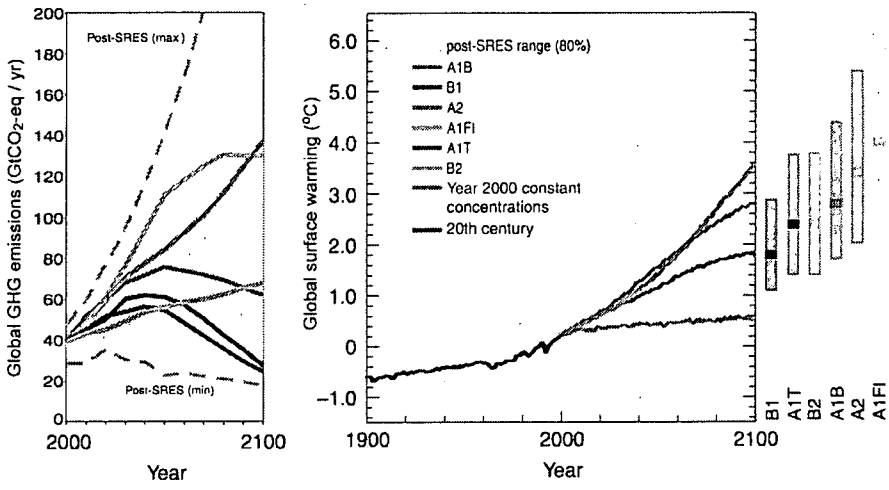


Figure SPM.5. Left Panel: Global GHG emissions (in CO_2-eq) in the absence of climate policies: six illustrative SRES marker scenarios (coloured lines) and the 80th percentile range of recent scenarios published since SRES (post-SRES) (gray shaded area). Dashed lines show the full range of post-SRES scenarios. The emissions cover CO_2, CH_4, N_2O, and F-gases. Right Panel: Solid lines are multi-model global averages of surface warming for scenarios A2, A1B and B1, shown as continuations of the 20th-century simulations. These projections also take into account emissions of short-lived GHGs and aerosols. The pink line is not a scenario, but is for Atmosphere-Ocean General Circulation Model (AOGCM) simulations where atmospheric concentrations are held constant at year 2000 values. The bars at the right of the figure indicate the best estimate (solid line within each bar) and the *likely* range assessed for the six SRES marker scenarios at 2090-2099. All temperatures are relative to the period 1980-1999. {Figures 3.1 and 3.2}

Table SPM.1. Projected global averaged surface warming and sea level rise at the end of the 21st century. {Table 3.1}

	Temperature change (°C at 2090-2099 relative to 1980-1999) [a, d]		Sea level rise (m at 2090-2099 relative to 1980-1999)
Case	Best estimate	*Likely* range	Model-based range excluding future rapid dynamical changes in ice flow
Constant year 2000 concentrations [b]	0.6	0.3 – 0.9	Not available
B1 scenario	1.8	1.1 – 2.9	0.18 – 0.38
A1T scenario	2.4	1.4 – 3.8	0.20 – 0.45
B2 scenario	2.4	1.4 – 3.8	0.20 – 0.43
A1B scenario	2.8	1.7 – 4.4	0.21 – 0.48
A2 scenario	3.4	2.0 – 5.4	0.23 – 0.51
A1FI scenario	4.0	2.4 – 6.4	0.26 – 0.59

Notes:

a) Temperatures are assessed best estimates and likely uncertainty ranges from a hierarchy of models of varying complexity as well as observational constraints.

b) Year 2000 constant composition is derived from Atmosphere-Ocean General Circulation Models (AOGCMs) only.

c) All scenarios above are six SRES marker scenarios. Approximate CO_2-eq concentrations corresponding to the computed radiative forcing due to anthropogenic GHGs and aerosols in 2100 (see p. 823 of the WGI TAR) for the SRES B1, AIT, B2, A1B, A2 and A1FI illustrative marker scenarios are about 600, 700, 800, 850, 1250 and 1550 ppm, respectively.

d) Temperature changes are expressed as the difference from the period 1980-1999. To express the change relative to the period 1850-1899 add 0.5 °C.

The range of projections (Table SPM.1) is broadly consistent with the TAR, but uncertainties and upper ranges for temperature are larger mainly because the broader range of available models suggests stronger climate-carbon cycle feedbacks. Warming reduces terrestrial and ocean uptake of atmospheric CO_2, increasing the fraction of anthropogenic emissions remaining in the atmosphere. The strength of this feedback effect varies markedly among models. {2.3, 3.2.1}

Because understanding of some important effects driving sea level rise is too limited, this report does not assess the likelihood, nor provide a best estimate or an upper bound for sea level rise. Table SPM.1 shows model-based projections of global average sea level rise for 2090-2099.[10] The projections do not include uncertainties in climate-carbon cycle feedbacks nor the full effects of changes in ice sheet flow, therefore the upper values of the ranges are not to be considered upper bounds for sea level rise. They include a contribution from increased Greenland and Antarctic ice flow at the rates observed for 1993-2003, but this could increase or decrease in the future.[11] {3.2.1}

There is now higher confidence than in the TAR in projected patterns of warming and other regional-scale features, including changes in wind patterns, precipitation, and some aspects of extremes and sea ice. {3.2.2}

Regional-scale changes include: {3.2.2}

- warming greatest over land and at most high northern latitudes and least over Southern Ocean and parts of the North Atlantic Ocean, continuing recent observed trends (Figure SPM.6).
- contraction of snow cover area, increases in thaw depth over most permafrost regions, and decrease in sea ice extent; in some projections using SRES scenarios, Arctic late-summer sea ice disappears almost entirely by the latter part of the 21st century
- *very likely* increase in frequency of hot extremes, heat waves, and heavy precipitation
- *likely* increase in tropical cyclone intensity; less confidence in global decrease of tropical cyclone numbers
- poleward shift of extra-tropical storm tracks with consequent changes in wind, precipitation, and temperature patterns
- *very likely* precipitation increases in high latitudes and *likely* decreases in most subtropical land regions, continuing observed recent trends.

There is *high confidence* that by mid-century, annual river runoff and water availability are projected to increase at high latitudes (and in some tropical wet areas) and decrease in some dry regions in the mid-latitudes and tropics. There is also *high confidence* that many semi-arid areas (e.g. Mediterranean basin, western United States, southern Africa and northeast Brazil) will suffer a decrease in water resources due to climate change. {3.3.1; Figure 3.5}

Geographical pattern of surface warming

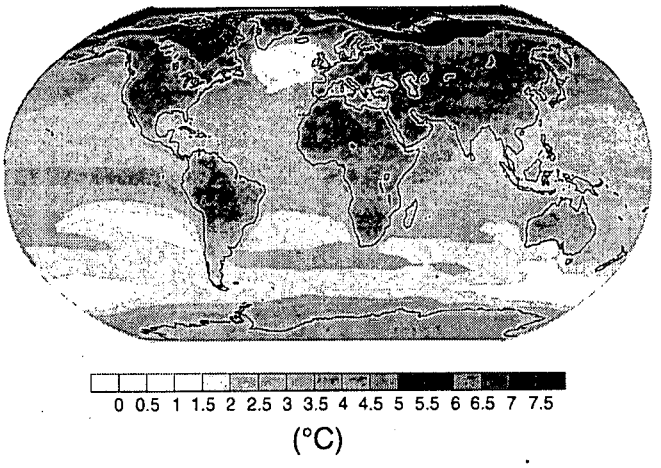


Figure SPM. 6. Projected surface temperature changes for the late 21st century (2090-2099). The map shows the multi-AOGCM average projection for the A1B SRES scenario. All temperatures are relative to the period 1980-1999. {Figure 3.2}

[10] TAR projections were made for 2100, whereas the projections for this report are for 2090-2099. The TAR would have had similar ranges to those in Table SPM.1 if it had treated uncertainties in the same way.

[11] For discussion of the longer term see material below.

Studies since the TAR have enabled more systematic understanding of the timing and magnitude of impacts related to differing amounts and rates of climate change. {3.3.1, 3.3.2}

Figure SPM.7 presents examples of this new information for systems and sectors. The top panel shows impacts increasing with increasing temperature change. Their estimated magnitude and timing is also affected by development pathway (lower panel). {3.3.1}

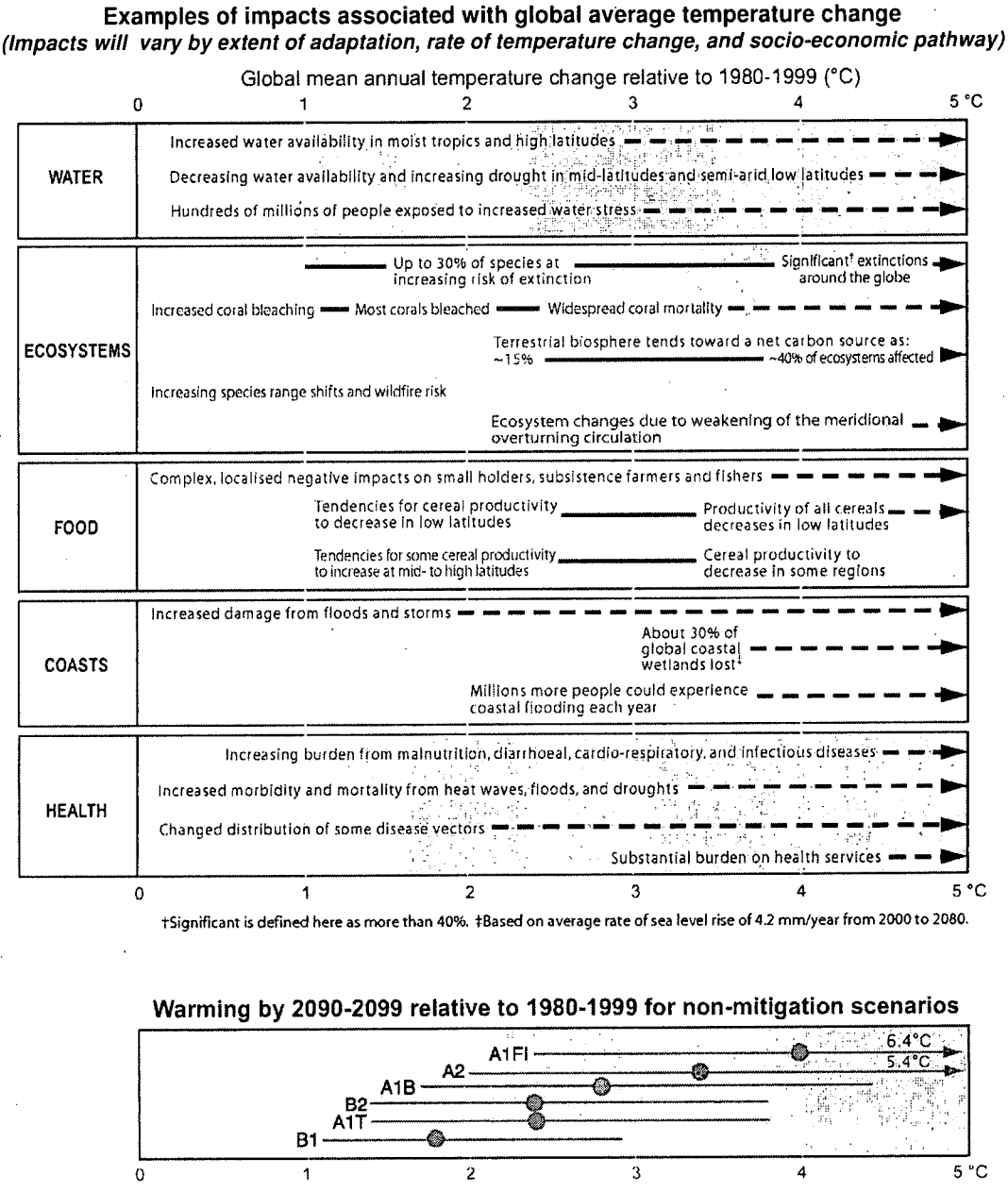


Figure SPM.7. Examples of impacts associated with projected global average surface warming. Upper panel: Illustrative examples of global impacts projected for climate changes (and sea level and atmospheric CO_2 where relevant) associated with different amounts of increase in global average surface temperature in the 21st century. The black lines link impacts; broken-line arrows indicate impacts continuing with increasing temperature. Entries are placed so that the left hand side of text indicates the approximate level of warming that is associated with the onset of a given impact. Quantitative entries for water scarcity and flooding represent the additional impacts of climate change relative to the conditions projected across the range of SRES scenarios A1FI, A2, B1 and B2. Adaptation to climate change is not included in these estimations. Confidence levels for all statements are *high*. Lower panel: Dots and bars indicate the best estimate and *likely* ranges of warming assessed for the six SRES marker scenarios for 2090-2099 relative to 1980-1999. {Figure 3.6}

Examples of some projected impacts for different regions are given in Table SPM.2.

Table SPM.2. Examples of some projected regional impacts. {3.3.2}

Africa	• By 2020, between 75 and 250 million of people are projected to be exposed to increased water stress due to climate change • By 2020, in some countries, yields from rain-fed agriculture could be reduced by up to 50%. Agricultural production, including access to food, in many African countries is projected to be severely compromised. This would further adversely affect food security and exacerbate malnutrition • Towards the end of the 21st century, projected sea-level rise will affect low-lying coastal areas with large populations. The cost of adaptation could amount to at least 5-10% of Gross Domestic Product (GDP) • By 2080, an increase of 5-8% of arid and semi-arid land in Africa is projected under a range of climate scenarios (TS)
Asia	• By the 2050s, freshwater availability in Central, South, East and South-EastAsia, particularly in large river basins, is projected to decrease • Coastal areas, especially heavily-populated megadelta regions in South, East and South-East Asia, will be at greatest risk due to increased flooding from the sea and, in some megadeltas, flooding from the rivers • Climate change is projected to compound the pressures on natural resources and the environment, associated with rapid urbanization, industrialization and economic development • Endemic morbidity and mortality due to diarrhoeal disease primarily associated with floods and droughts are expected to rise in East, South and South-East Asia due to projected changes in the hydrological cycle
Australia and New Zealand	• By 2020, significant loss of biodiversity is projected to occur in some ecologically rich sites including the Great Barrier Reef and Queensland Wet Tropics • By 2030, water security problems are projected to intensify in southern and eastern Australia and, in New Zealand, in Northland and some eastern regions • By 2030, production from agriculture and forestry is projected to decline over much of southern and eastern Australia, and over parts of eastern New Zealand, due to increased drought and fire. However, in New Zealand, initial benefits are projected in some other regions • By 2050, ongoing coastal development and population growth in some areas of Australia and New Zealand are projected to exacerbate risks from sea level rise and increases in the severity and frequency of storms and coastal flooding
Europe	• Climate change is expected to magnify regional differences in Europe's natural resources and assets. Negative impacts will include increased risk of inland flash floods, and more frequent coastal flooding and increased erosion (due to storminess and sea-level rise) • Mountainous areas will face glacier retreat, reduced snow cover and winter tourism, and extensive species losses (in some areas up to 60% under high emissions scenarios by 2080) • In Southern Europe, climate change is projected to worsen conditions (high temperatures and drought) in a region already vulnerable to climate variability, and to reduce water availability, hydropower potential, summer tourism and, in general, crop productivity • Climate change is also projected to increase the health risks due to heat-waves, and the frequency of wildfires
Latin America	• By mid century, increases in temperature and associated decreases in soil water are projected to lead to gradual replacement of tropical forest by savanna in eastern Amazonia. Semi-arid vegetation will tend to be replaced by arid-land vegetation • There is a risk of significant biodiversity loss through species extinction in many areas of tropical Latin America • Productivity of some important crops is projected to decrease and livestock productivity to decline, with adverse consequences for food security. In temperate zones soybean yields are projected to increase. Overall, the number of people at risk of hunger is projected to increase (TS; *medium confidence*) • Changes in precipitation patterns and the disappearance of glaciers are projected to significantly affect water availability for human consumption, agriculture and energy generation
North America	• Warming in western mountains is projected to cause decreased snowpack, more winter flooding, and reduced summer flows, exacerbating competition for over-allocated water resources • In the early decades of the century, moderate climate change is projected to increase aggregate yields of rain-fed agriculture by 5-20%, but with important variability among regions. Major challenges are projected for crops that are near the warm end of their suitable range or which depend on highly utilized water resources • During the course of this century, cities that currently experience heatwaves are expected to be further challenged by an increased number, intensity and duration of heatwaves during the course of the century, with potential for adverse health impacts • Coastal communities and habitats will be increasingly stressed by climate change impacts interacting with development and pollution
Polar Regions	• The main projected biophysical effects are reductions in thickness and extent of glaciers and ice sheets and sea ice, and changes in natural ecosystems with detrimental effects on many organisms including migratory birds, mammals and higher predators • For human communities in the Arctic, impacts, particularly those resulting from changing snow and ice conditions are projected to be mixed • Detrimental impacts would include those on infrastructure and traditional indigenous ways of life • In both polar regions, specific ecosystems and habitats are projected to be vulnerable, as climatic barriers to species invasions are lowered

Table SPM.2. (cont.)

Small Islands	• Sea-level rise is expected to exacerbate inundation, storm surge, erosion and other coastal hazards, thus threatening vital infrastructure, settlements and facilities that support the livelihood of island communities • Deterioration in coastal conditions, for example through erosion of beaches and coral bleaching is expected to affect local resources • By mid-century, climate change is expected to reduce water resources in many small islands, e.g. in the Caribbean and Pacific, to the point where they become insufficient to meet demand during low-rainfall periods • With higher temperatures, increased invasion by non-native species is expected to occur, particularly on mid- and high-latitude islands

Note: Unless stated explicitly, all entries are from WGII SPM text, and are either very high confidence or high confidence statements, reflecting different sectors (Agriculture, Ecosystems, Water, Coasts, Health, Industry and Settlements). The WGII SPM refers to the source of the statements, timelines and temperatures. The magnitude and timing of impacts that will ultimately be realized will vary with the amount and rate of climate change, emission scenarios, development pathways and adaptation.

Some systems, sectors and regions are *likely* to be especially affected by climate change.[12] {3.3.3}

Systems and sectors: {3.3.3}

- particular ecosystems:
  - terrestrial: tundra, boreal forest and mountain regions because of sensitivity to warming; mediterranean-type ecosystems because of reduction in rainfall; and tropical rainforests where precipitation declines
  - coastal: mangroves and salt marshes, due to multiple stresses
  - marine: coral reefs due to multiple stresses; the sea ice biome because of sensitivity to warming
- water resources in some dry regions at mid-latitudes[13] and in the dry tropics, due to changes in rainfall and evapotranspiration, and in areas dependent on snow and ice melt
- agriculture in low-latitudes, due to reduced water availability
- low-lying coastal systems, due to threat of sea level rise and increased risk from extreme weather events
- human health in populations with low adaptive capacity.

Regions: {3.3.3}

- the Arctic, because of the impacts of high rates of projected warming on natural systems and human communities
- Africa, because of low adaptive capacity and projected climate change impacts
- small islands, where there is high exposure of population and infrastructure to projected climate change impacts
- Asian and African megadeltas, due to large populations and high exposure to sea level rise, storm surges and river flooding.

Within other areas, even those with high incomes, some people (such as the poor, young children, and the elderly) can be particularly at risk, and also some areas and some activities. {3.3.3}

Ocean Acidification

The uptake of anthropogenic carbon since 1750 has led to the ocean becoming more acidic with an average decrease in pH of 0.1 units. Increasing atmospheric CO_2 concentrations lead to further acidification. Projections based on SRES scenarios give a reduction in average global surface ocean pH of between 0.14 and 0.35 units over the 21st century. While the effects of observed ocean acidification on the marine biosphere are as yet undocumented, the progressive acidification of oceans is expected to have negative impacts on marine shell-forming organisms (e.g. corals) and their dependent species. {3.3.4}

[12] Identified on the basis of expert judgement of the assessed literature and considering the magnitude, timing and projected rate of climate change, sensitivity and adaptive capacity.

[13] Including arid and semi-arid regions.

Altered frequencies and intensities of extreme weather, together with sea level rise, are expected to have mostly adverse effects on natural and human systems. {3.3.5}

Examples for selected extremes and sectors are shown in Table SPM.3. {Table 3.2}

Table SPM.3. Examples of possible impacts of climate change due to changes in extreme weather and climate events, based on projections to the mid- to late 21st century. These do not take into account any changes or developments in adaptive capacity. The likelihood estimates in column two relate to the phenomena listed in column one. {Table 3.2}

Phenomenon[a] and direction of trend	Likelihood of future trends based on projections for 21st century using SRES scenarios	Examples of major projected impacts by sector			
		Agriculture, forestry and ecosystems	Water resources	Human health	Industry, settlement and society
Over most land areas, warmer and fewer cold days and nights, warmer and more frequent hot days and nights	*Virtually certain*[b]	Increased yields in colder environments; decreased yields in warmer environments; increased insect outbreaks	Effects on water resources relying on snowmelt; effects on some water supplies	Reduced human mortality from decreased cold exposure	Reduced energy demand for heating; increased demand for cooling; declining air quality in cities; reduced disruption to transport due to snow, ice; effects on winter tourism
Warm spells/heat waves. Frequency increases over most land areas	*Very likely*	Reduced yields in warmer regions due to heat stress; increased danger of wildfire	Increased water demand; water quality problems, e.g. algal blooms	Increased risk of heat-related mortality, especially for the elderly, chronically sick, very young and socially isolated	Reduction in quality of life for people in warm areas without appropriate housing; impacts on the elderly, very young and poor
Heavy precipitation events. Frequency increases over most areas	*Very likely*	Damage to crops; soil erosion, inability to cultivate land due to waterlogging of soils	Adverse effects on quality of surface and groundwater; contamination of water supply; water scarcity may be relieved	Increased risk of deaths, injuries and infectious, respiratory and skin diseases	Disruption of settlements, commerce, transport and societies due to flooding; pressures on urban and rural infrastructures; loss of property
Area affected by drought increases	*Likely*	Land degradation; lower yields/crop damage and failure; increased livestock deaths; increased risk of wildfire	More widespread water stress	Increased risk of food and water shortage; increased risk of malnutrition; increased risk of water-and food-borne diseases	Water shortage for settlements, industry and societies; reduced hydropower generation potentials; potential for population migration
Intense tropical cyclone activity increases	*Likely*	Damage to crops; windthrow (uprooting) of trees; damage to coral reefs	Power outages causing disruption of public water supply	Increased risk of deaths, injuries, water- and food-borne diseases; post-traumatic stress disorders	Disruption by flood and high winds; withdrawal of risk coverage in vulnerable areas by private insurers, potential for population migrations, loss of property
Increased incidence of extreme high sea level (excludes tsunamis)[c]	*Likely*[d]	Salinisation of irrigation water, estuaries and freshwater systems	Decreased freshwater availability due to saltwater intrusion	Increased risk of deaths and injuries by drowning in floods; migration-related health effects	Costs of coastal protection versus costs of land-use relocation; potential for movement of populations and infrastructure; also see tropical cyclones above

Notes:

a) See WGI Table 3.7 for further details regarding definitions.

b) Warming of the most extreme days and nights each year.

c) Extreme high sea level depends on average sea level and on regional weather systems. It is defined as the highest 1% of hourly values of observed sea level at a station for a given reference period.

d) In all scenarios, the projected global average sea level at 2100 is higher than in the reference period. The effect of changes in regional weather systems on sea level extremes has not been assessed.

Anthropogenic warming and sea level rise would continue for centuries due to the time scales associated with climate processes and feedbacks, even if GHG concentrations were to be stabilised. {3.2.3}

Estimated long-term (multi-century) warming corresponding to the six AR4 WG III stabilisation categories is shown in Figure SPM.8.

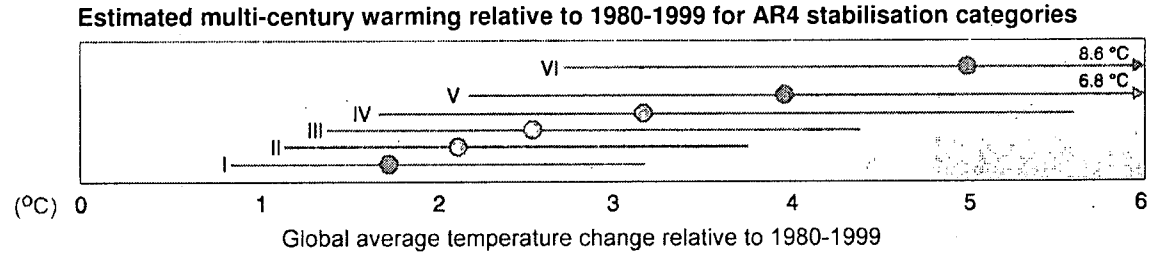


Figure SPM.8. Estimated long-term (multi-century) warming corresponding to the six AR4 WGIII stabilisation categories (Table SPM.6). Temperature scale has been shifted by -0.5°C compared to Table SPM.6 to account approximately for the warming between pre-industrial and 1980-1999. For most stabilisation levels global average temperature is approaching the equilibrium level over a few centuries. For GHG emission scenarios that lead to stabilisation by 2100 at levels comparable to SRES B1 and A1B (600 and 850 ppm CO_2-eq; category IV and V) assessed models project that about 65-70% of the estimated global equilibrium temperature increase assuming a climate sensitivity of 3°C would be realised at the time of stabilisation. For the much lower stabilisation scenarios (category I and II, Figure SPM.11), the equilibrium temperature may be reached earlier. {Figure 3.4}

Contraction of the Greenland ice sheet is projected to continue to contribute to sea level rise after 2100. Current models suggest virtually complete elimination of the Greenland ice sheet and a resulting contribution to sea level rise of about 7 m if global average warming were sustained for millennia in excess of 1.9 to 4.6°C relative to pre-industrial values. The corresponding future temperatures in Greenland are comparable to those inferred for the last interglacial period 125,000 years ago, when palaeoclimatic information suggests reductions of polar land ice extent and 4 to 6 m of sea level rise. {3.2.3}

Current global model studies project that the Antarctic ice sheet will remain too cold for widespread surface melting and gain mass due to increased snowfall. However, net loss of ice mass could occur if dynamical ice discharge dominates the ice sheet mass balance. {3.2.3}

Anthropogenic warming could lead to some impacts that are abrupt or irreversible, depending upon the rate and magnitude of the climate change. {3.4}

Partial loss of ice sheets on polar land could imply metres of sea level rise, major changes in coastlines and inundation of low-lying areas, with greatest effects in river deltas and low-lying islands. Such changes are projected to occur over millennial time scales, but more rapid sea level rise on century time scales cannot be excluded. {3.4}

Climate change is *likely* to lead to some irreversible impacts. There is *medium confidence* that approximately 20-30% of species assessed so far are *likely* to be at increased risk of extinction if increases in global average warming exceed 1.5-2.5°C (relative to 1980-1999). As global average temperature increase exceeds about 3.5°C, model projections suggest significant extinctions (40-70% of species assessed) around the globe. {3.4}

Based on current model simulations, the meridional overturning circulation (MOC) of the Atlantic Ocean will *very likely* slow down during the 21st century; nevertheless temperatures over the Atlantic and Europe are projected to increase. The MOC is *very unlikely* to undergo a large abrupt transition during the 21st century. Longer-term MOC changes cannot be assessed with confidence. Impacts of large-scale and persistent changes in the MOC are *likely* to include changes in marine ecosystem productivity, fisheries, ocean CO_2 uptake, oceanic oxygen concentrations and terrestrial vegetation. Changes in terrestrial and ocean CO_2 uptake may feed back on the climate system. {3.4}

4. Adaptation and mitigation options[14]

A wide array of adaptation options is available, but more extensive adaptation than is currently occurring is required to reduce vulnerability to climate change. There are barriers, limits and costs, which are not fully understood. {4.2}

Societies have a long record of managing the impacts of weather- and climate-related events. Nevertheless, additional adaptation measures will be required to reduce the adverse impacts of projected climate change and variability, regardless of the scale of mitigation undertaken over the next two to three decades. Moreover, vulnerability to climate change can be exacerbated by other stresses. These arise from, for example, current climate hazards, poverty and unequal access to resources, food insecurity, trends in economic globalisation, conflict and incidence of diseases such as HIV/AIDS. {4.2}

Some planned adaptation to climate change is already occurring on a limited basis. Adaptation can reduce vulnerability especially when it is embedded within broader sectoral initiatives (Table SPM.4). There is *high confidence* that there are viable adaptation options that can be implemented in some sectors at low cost, and/or with high benefit-cost ratios. However, comprehensive estimates of global costs and benefits of adaptation are limited. {4.2, Table 4.1}

Adaptive capacity is intimately connected to social and economic development but is unevenly distributed across and within societies. {4.2}

A range of barriers limit both the implementation and effectiveness of adaptation measures. The capacity to adapt is dynamic and is influenced by a society's productive base including: natural and man-made capital assets, social networks and entitlements, human capital and institutions, governance, national income, health and technology. Even societies with high adaptive capacity remain vulnerable to climate change, variability and extremes. {4.2}

Both bottom-up and top-down studies indicate that there is *high agreement* and *much evidence* of substantial economic potential for the mitigation of global GHG emissions over the coming decades that could offset the projected growth of global emissions or reduce emissions below current levels (Figures SPM.9, SPM.10)[15]. While top-down and bottom-up studies are in line at the global level (Figure SPM.9) there are considerable differences at the sectoral level. {4.3}

No single technology can provide all of the mitigation potential in any sector. The economic mitigation potential, which is generally greater than the market mitigation potential, can only be achieved when adequate policies are in place and barriers removed (Table SPM.5). {4.3}

Bottom-up studies suggest that mitigation opportunities with net negative costs have the potential to reduce emissions by around 6 $GtCO_2$-eq/yr in 2030, realizing which requires dealing with implementation barriers. {4.3}

[14] While this section deals with adaptation and mitigation separately, these responses can be complementary. This theme is discussed in section 5.

[15] The concept of "**mitigation potential**" has been developed to assess the scale of GHG reductions that could be made, relative to emission baselines, for a given level of carbon price (expressed in cost per unit of carbon dioxide equivalent emissions avoided or reduced). Mitigation potential is further differentiated in terms of "market mitigation potential" and "economic mitigation potential".

Market mitigation potential is the mitigation potential based on private costs and private discount rates (reflecting the perspective of private consumers and companies), which might be expected to occur under forecast market conditions, including policies and measures currently in place, noting that barriers limit actual uptake.

Economic mitigation potential is the mitigation potential that takes into account social costs and benefits and social discount rates (reflecting the perspective of society; social discount rates are lower than those used by private investors), assuming that market efficiency is improved by policies and measures and barriers are removed.

Mitigation potential is estimated using different types of approaches. ***Bottom-up studies*** are based on assessment of mitigation options, emphasizing specific technologies and regulations. They are typically sectoral studies taking the macro-economy as unchanged. ***Top-down studies*** assess the economy-wide potential of mitigation options. They use globally consistent frameworks and aggregated information about mitigation options and capture macro-economic and market feedbacks.

Table SPM.4. Selected examples of planned adaptation by sector.

Sector	Adaptation option/strategy	Underlying policy framework	Key constraints and opportunities to implementation (Normal font = constraints; *Italics = opportunities*)
Water	Expanded rainwater harvesting; water storage and conservation techniques; water re-use; desalination; water-use and irrigation efficiency	National water policies and integrated water resources management; water-related hazards management	Financial, human resources and physical barriers; *integrated water resources management; synergies with other sectors*
Agriculture	Adjustment of planting dates and crop variety; crop relocation; improved land management, e.g. erosion control and soil protection through tree planting	R&D policies; institutional reform; land tenure and land reform; training; capacity building; crop insurance; financial incentives, e.g. subsidies and tax credits	Technological & financial constraints; access to new varieties; markets; *longer growing season in higher latitudes; revenues from 'new' products*
Infrastructure/settlement (including coastal zones)	Relocation; seawalls and storm surge barriers; dune reinforcement; land acquisition and creation of marshlands/wetlands as buffer against sea level rise and flooding; protection of existing natural barriers	Standards and regulations that integrate climate change considerations into design; land use policies; building codes; insurance	Financial and technological barriers; availability of relocation space; *integrated policies and managements; synergies with sustainable development goals*
Human health	Heat-health action plans; emergency medical services; improved climate-sensitive disease surveillance and control; safe water and improved sanitation	Public health policies that recognise climate risk; strengthened health services; regional and international cooperation	Limits to human tolerance (vulnerable groups); knowledge limitations; financial capacity; *upgraded health services; improved quality of life*
Tourism	Diversification of tourism attractions & revenues; shifting ski slopes to higher altitudes and glaciers; artificial snow-making	Integrated planning (e.g. carrying capacity; linkages with other sectors); financial incentives, e.g. subsidies and tax credits	Appeal/marketing of new attractions; financial and logistical challenges; potential adverse impact on other sectors (e.g. artificial snow-making may increase energy use); *revenues from 'new' attractions; involvement of wider group of stakeholders*
Transport	Realignment/relocation; design standards and planning for roads, rail, and other infrastructure to cope with warming and drainage	Integrating climate change considerations into national transport policy; investment in R&D for special situations, e.g. permafrost areas	Financial & technological barriers; availability of less vulnerable routes; *improved technologies and integration with key sectors (e.g. energy)*
Energy	Strengthening of overhead transmission and distribution infrastructure; underground cabling for utilities; energy efficiency; use of renewable sources; reduced dependence on single sources of energy	National energy policies, regulations, and fiscal and financial incentives to encourage use of alternative sources; incorporating climate change in design standards	Access to viable alternatives; financial and technological barriers; acceptance of new technologies; *stimulation of new technologies; use of local resources*

Note: Other examples from many sectors would include early warning systems.

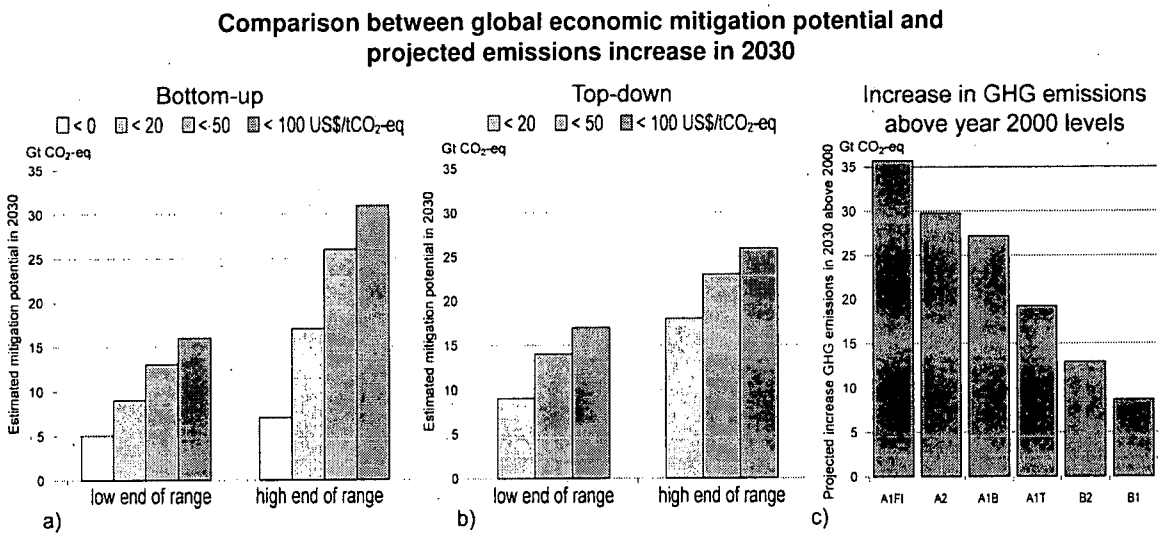


Figure SPM.9. Global economic mitigation potential in 2030 estimated from bottom-up (Panel a) and top-down (Panel b) studies, compared with the projected emission increases from SRES scenarios relative to 2000 GHG emissions of 40.8 $GtCO_2$-eq (Panel c). Note: GHG emissions in 2000 are exclusive of emissions of decay of above ground biomass that remains after logging and deforestation and from peat fires and drained peat soils, to ensure consistency with the SRES emission results. {Figure 4.1}

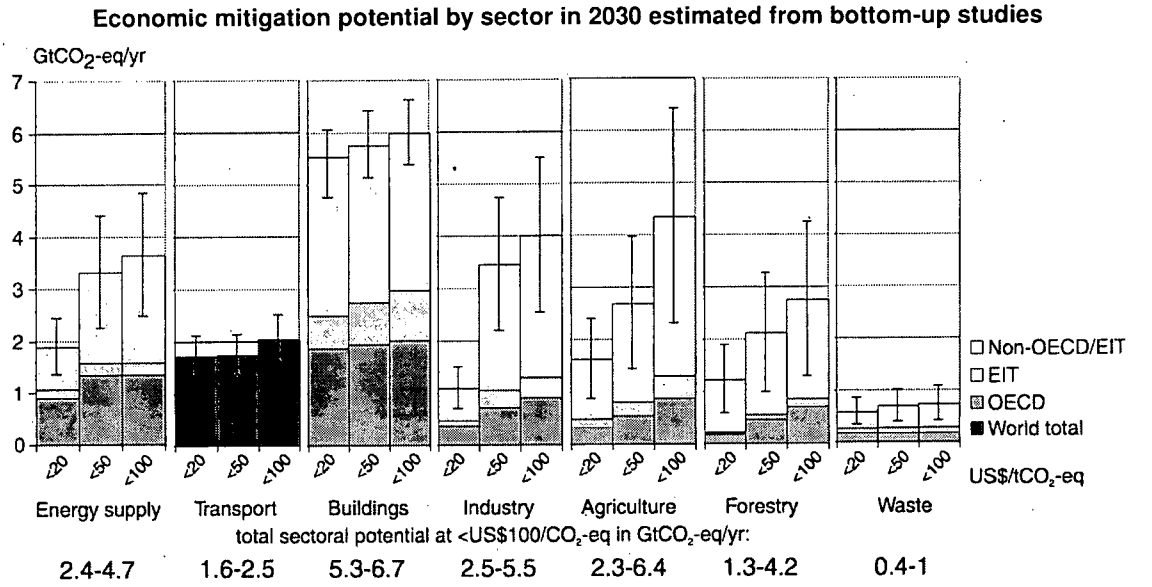


Figure SPM.10. Estimated economic mitigation potential by sector in 2030 from bottom-up studies, compared to the respective baselines assumed in the sector assessments. The potentials do not include non-technical options such as lifestyle changes. {Figure 4.2}

Notes:

a) The ranges for global economic potentials as assessed in each sector are shown by vertical lines. The ranges are based on end-use allocations of emissions, meaning that emissions of electricity use are counted towards the end-use sectors and not to the energy supply sector.

b) The estimated potentials have been constrained by the availability of studies particularly at high carbon price levels.

c) Sectors used different baselines. For industry the SRES B2 baseline was taken, for energy supply and transport the WEO 2004 baseline was used; the building sector is based on a baseline in between SRES B2 and A1B; for waste, SRES A1B driving forces were used to construct a waste specific baseline; agriculture and forestry used baselines that mostly used B2 driving forces.

d) Only global totals for transport are shown because international aviation is included.

e) Categories excluded are: non-CO_2 emissions in buildings and transport, part of material efficiency options, heat production and cogeneration in energy supply, heavy duty vehicles, shipping and high-occupancy passenger transport, most high-cost options for buildings, wastewater treatment, emission reduction from coal mines and gas pipelines, fluorinated gases from energy supply and transport. The underestimation of the total economic potential from these emissions is of the order of 10-15%.

Table SPM.5. Selected examples of key sectoral mitigation technologies, policies and measures, constraints and opportunities. {Table 4.2}

Sector	Key mitigation technologies and practices currently commercially available. *Key mitigation technologies and practices projected to be commercialised before 2030 shown in italics.*	Policies, measures and instruments shown to be environmentally effective	Key constraints or opportunities (Normal font = constraints; *italics = opportunities*)
Energy Supply	Improved supply and distribution efficiency; fuel switching from coal to gas; nuclear power; renewable heat and power (hydropower, solar, wind, geothermal and bioenergy); combined heat and power; early applications of Carbon Dioxide Capture and Storage (CCS) (e.g. storage of removed CO_2 from natural gas); *CCS for gas, biomass and coal-fired electricity generating facilities; advanced nuclear power; advanced renewable energy, including tidal and wave energy, concentrating solar, and solar photovoltaics*	Reduction of fossil fuel subsidies; Taxes or carbon charges on fossil fuels	Resistance by vested interests may make them difficult to implement
		Feed-in tariffs for renewable energy technologies; Renewable energy obligations; Producer subsidies	*May be appropriate to create markets for low emissions technologies*
Transport	More fuel efficient vehicles; hybrid vehicles; cleaner diesel vehicles; biofuels; modal shifts from road transport to rail and public transport systems; non-motorised transport (cycling, walking); land-use and transport planning; *Second generation biofuels; higher efficiency aircraft; advanced electric and hybrid vehicles with more powerful and reliable batteries*	Mandatory fuel economy, biofuel blending and CO_2 standards for road transport	Partial coverage of vehicle fleet may limit effectiveness
		Taxes on vehicle purchase, registration, use and motor fuels, road and parking pricing	Effectiveness may drop with higher incomes
		Influence mobility needs through land use regulations, and infrastructure planning; Investment in attractive public transport facilities and non-motorised forms of transport	*Particularly appropriate for countries that are building up their transportation systems*
Buildings	Efficient lighting and daylighting; more efficient electrical appliances and heating and cooling devices; improved cook stoves, improved insulation; passive and active solar design for heating and cooling; alternative refrigeration fluids, recovery and recycling of fluorinated gases; *Integrated design of commercial buildings including technologies, such as intelligent meters that provide feedback and control; solar photovoltaics integrated in buildings*	Appliance standards and labelling	Periodic revision of standards needed
		Building codes and certification	*Attractive for new buildings.* Enforcement can be difficult
		Demand-side management programmes	Need for regulations so that utilities may profit
		Public sector leadership programmes, including procurement	*Government purchasing can expand demand for energy-efficient products*
		Incentives for energy service companies (ESCOs)	*Success factor: Access to third party financing*
Industry	More efficient end-use electrical equipment; heat and power recovery; material recycling and substitution; control of non-CO_2 gas emissions; and a wide array of process-specific technologies; *Advanced energy efficiency; CCS for cement, ammonia, and iron manufacture; inert electrodes for aluminium manufacture*	Provision of benchmark information; Performance standards; Subsidies, tax credits	*May be appropriate to stimulate technology uptake.* Stability of national policy important in view of international competitiveness
		Tradable permits	Predictable allocation mechanisms and stable price signals important for investments
		Voluntary agreements	Success factors include: clear targets, a baseline scenario, third party involvement in design and review and formal provisions of monitoring, close cooperation between government and industry
Agriculture	Improved crop and grazing land management to increase soil carbon storage; restoration of cultivated peaty soils and degraded lands; improved rice cultivation techniques and livestock and manure management to reduce CH_4 emissions; improved nitrogen fertiliser application techniques to reduce N_2O emissions; dedicated energy crops to replace fossil fuel use; improved energy efficiency; *Improvements of crop yields*	Financial incentives and regulations for improved land management, maintaining soil carbon content, efficient use of fertilisers and irrigation	*May encourage synergy with sustainable development and with reducing vulnerability to climate change, thereby overcoming barriers to implementation*

Table SPM.5. (cont.)

Sector	Key mitigation technologies and practices currently commercially available. *Key mitigation technologies and practices projected to be commercialised before 2030 shown in italics.*	Policies, measures and instruments shown to be environmentally effective	Key constraints or opportunities (Normal font = constraints; *Italics = opportunities*)
Forestry/ forests	Afforestation; reforestation; forest management; reduced deforestation; harvested wood product management; use of forestry products for bioenergy to replace fossil fuel use; *Tree species improvement to increase biomass productivity and carbon sequestration. Improved remote sensing technologies for analysis of vegetation/ soil carbon sequestration potential and mapping land use change*	Financial incentives (national and international) to increase forest area, to reduce deforestation, and to maintain and manage forests; land-use regulation and enforcement	Constraints include lack of investment capital and land tenure issues. *Can help poverty alleviation*
Waste	Landfill CH_4 recovery; waste incineration with energy recovery; composting of organic waste; controlled waste water treatment; recycling and waste minimisation; *biocovers and biofilters to optimise CH_4 oxidation*	Financial incentives for improved waste and wastewater management	*May stimulate technology diffusion*
		Renewable energy incentives or obligations	Local availability of low-cost fuel
		Waste management regulations	Most effectively applied at national level with enforcement strategies

Future energy infrastructure investment decisions, expected to exceed 20 trillion US$[16] between 2005 and 2030, will have long-term impacts on GHG emissions, because of the long life-times of energy plants and other infrastructure capital stock. The widespread diffusion of low-carbon technologies may take many decades, even if early investments in these technologies are made attractive. Initial estimates show that returning global energy-related CO_2 emissions to 2005 levels by 2030 would require a large shift in investment patterns, although the net additional investment required ranges from negligible to 5-10%. {4.3}

A wide variety of policies and instruments are available to governments to create the incentives for mitigation action. Their applicability depends on national circumstances and sectoral context (Table SPM.5). {4.3}

They include integrating climate policies in wider development policies, regulations and standards, taxes and charges, tradable permits, financial incentives, voluntary agreements, information instruments, and research, development and demonstration (RD&D). {4.3}

An effective carbon-price signal could realise significant mitigation potential in all sectors. Modelling studies show global carbon prices rising to 20-80 US$/t$CO_2$-eq by 2030 are consistent with stabilisation at around 550 ppm CO_2-eq by 2100. For the same stabilisation level, induced technological change may lower these price ranges to 5-65 US$/t$CO_2$-eq in 2030.[17] {4.3}

There is *high agreement* and *much evidence* that mitigation actions can result in near-term co-benefits (e.g. improved health due to reduced air pollution) that may offset a substantial fraction of mitigation costs. {4.3}

There is *high agreement* and *medium evidence* that Annex I countries' actions may affect the global economy and global emissions, although the scale of carbon leakage remains uncertain.[18] {4.3}

[16] 20 trillion = 20,000 billion = 20×10^{12}

[17] Studies on mitigation portfolios and macro-economic costs assessed in this report are based on top-down modelling. Most models use a global least cost approach to mitigation portfolios, with universal emissions trading, assuming transparent markets, no transaction cost, and thus perfect implementation of mitigation measures throughout the 21st century. Costs are given for a specific point in time. Global modelled costs will increase if some regions, sectors (e.g. land-use), options or gases are excluded. Global modelled costs will decrease with lower baselines, use of revenues from carbon taxes and auctioned permits, and if induced technological learning is included. These models do not consider climate benefits and generally also co-benefits of mitigation measures, or equity issues. Significant progress has been achieved in applying approaches based on induced technological change to stabilisation studies; however, conceptual issues remain. In the models that consider induced technological change, projected costs for a given stabilisation level are reduced; the reductions are greater at lower stabilisation level.

[18] Further details may be found in Topic 4 of this Synthesis Report.

Fossil fuel exporting nations (in both Annex I and non-Annex I countries) may expect, as indicated in the TAR, lower demand and prices and lower GDP growth due to mitigation policies. The extent of this spill over depends strongly on assumptions related to policy decisions and oil market conditions. {4.3}

There is also *high agreement* and *medium evidence* that changes in lifestyle, behaviour patterns and management practices can contribute to climate change mitigation across all sectors. {4.3}

Many options for reducing global GHG emissions through international cooperation exist. There is *high agreement* and *much evidence* that notable achievements of the UNFCCC and its Kyoto Protocol are the establishment of a global response to climate change, stimulation of an array of national policies, and the creation of an international carbon market and new institutional mechanisms that may provide the foundation for future mitigation efforts. Progress has also been made in addressing adaptation within the UNFCCC and additional international initiatives have been suggested. {4.5}

Greater cooperative efforts and expansion of market mechanisms will help to reduce global costs for achieving a given level of mitigation, or will improve environmental effectiveness. Efforts can include diverse elements such as emissions targets; sectoral, local, sub-national and regional actions; RD&D programmes; adopting common policies; implementing development oriented actions; or expanding financing instruments. {4.5}

In several sectors, climate response options can be implemented to realise synergies and avoid conflicts with other dimensions of sustainable development. Decisions about macroeconomic and other non-climate policies can significantly affect emissions, adaptive capacity and vulnerability. {4.4, 5.8}

Making development more sustainable can enhance mitigative and adaptive capacities, reduce emissions, and reduce vulnerability, but there may be barriers to implementation. On the other hand, it is *very likely* that climate change can slow the pace of progress towards sustainable development. Over the next half-century, climate change could impede achievement of the Millennium Development Goals. {5.8}

5. The long-term perspective

Determining what constitutes "dangerous anthropogenic interference with the climate system" in relation to Article 2 of the UNFCCC involves value judgements. Science can support informed decisions on this issue, including by providing criteria for judging which vulnerabilities might be labelled "key". {Box 'Key Vulnerabilities and Article 2 of the UNFCCC', Topic 5}

Key vulnerabilities[19] may be associated with many climate sensitive systems including food supply, infrastructure, health, water resources, coastal systems, ecosystems, global biogeochemical cycles, ice sheets, and modes of oceanic and atmospheric circulation.{Box 'Key Vulnerabilities and Article 2 of the UNFCCC', Topic 5}

The five "reasons for concern" identified in the TAR remain a viable framework to consider key vulnerabilities. These "reasons" are assessed here to be stronger than in the TAR. Many risks are identified with higher confidence. Some risks are projected to be larger or to occur at lower increases in temperature. Understanding about the relationship between impacts (the basis for "reasons for concern" in the TAR) and vulnerability (that includes the ability to adapt to impacts) has improved. {5.2}

This is due to more precise identification of the circumstances that make systems, sectors and regions especially vulnerable, and growing evidence of the risks of very large impacts on multiple century time scales. {5.2}

[19] Key Vulnerabilities can be identified based on a number of criteria in the literature, including magnitude, timing, persistence/reversibility, the potential for adaptation, distributional aspects, likelihood and 'importance' of the impacts.

- **Risks to unique and threatened systems.** There is new and stronger evidence of observed impacts of climate change on unique and vulnerable systems (such as polar and high mountain communities and ecosystems), with increasing levels of adverse impacts as temperatures increase further. An increasing risk of species extinction and coral reef damage is projected with higher confidence than in the TAR as warming proceeds. There is *medium confidence* that approximately 20-30% of plant and animal species assessed so far are *likely* to be at increased risk of extinction if increases in global average temperature exceed 1.5-2.5°C over 1980-1999 levels. Confidence has increased that a 1-2°C increase in global mean temperature above 1990 levels (about 1.5-2.5°C above pre-industrial) poses significant risks to many unique and threatened systems including many biodiversity hotspots. Corals are vulnerable to thermal stress and have low adaptive capacity. Increases in sea surface temperature of about 1-3°C are projected to result in more frequent coral bleaching events and widespread mortality, unless there is thermal adaptation or acclimatization by corals. Increasing vulnerability of indigenous communities in the Arctic and small island communities to warming is projected. {5.2}
- **Risks of extreme weather events.** Responses to some recent extreme events reveal higher levels of vulnerability than the TAR. There is now higher confidence in the projected increases in droughts, heat waves, and floods as well as their adverse impacts. {5.2}
- **Distribution of impacts and vulnerabilities.** There are sharp differences across regions and those in the weakest economic position are often the most vulnerable to climate change. There is increasing evidence of greater vulnerability of specific groups such as the poor and elderly in not only developing but also developed countries. Moreover, there is increased evidence that low-latitude and less-developed areas generally face greater risk, for example in dry areas and megadeltas. {5.2}
- **Aggregate impacts.** Compared to the TAR, initial net market-based benefits from climate change are projected to peak at a lower magnitude of warming, while damages would be higher for larger magnitudes of warming. The net costs of impacts of increased warming are projected to increase over time. {5.2}
- **Risks of large-scale singularities.** There is *high confidence* that global warming over many centuries would lead to a sea level rise contribution from thermal expansion alone which is projected to be much larger than observed over the 20th century, with loss of coastal area and associated impacts. There is better understanding than in the TAR that the risk of additional contributions to sea level rise from both the Greenland and possibly Antarctic ice sheets may be larger than projected by ice sheet models and could occur on century time scales. This is because ice dynamical processes seen in recent observations but not fully included in ice sheet models assessed in AR4 could increase the rate of ice loss. {5.2}

There is *high confidence* that neither adaptation nor mitigation alone can avoid all climate change impacts; however, they can complement each other and together can significantly reduce the risks of climate change. {5.3}

Adaptation is necessary in the short and longer term to address impacts resulting from the warming that would occur even for the lowest stabilisation scenarios assessed. There are barriers, limits and costs, but these are not fully understood. Unmitigated climate change would, in the long term, be *likely* to exceed the capacity of natural, managed and human systems to adapt. The time at which such limits could be reached will vary between sectors and regions. Early mitigation actions would avoid further locking in carbon intensive infrastructure and reduce climate change and associated adaptation needs. {5.2, 5.3}

Many impacts can be reduced, delayed or avoided by mitigation. Mitigation efforts and investments over the next two to three decades will have a large impact on opportunities to achieve lower stabilisation levels. Delayed emission reductions significantly constrain the opportunities to achieve lower stabilisation levels and increase the risk of more severe climate change impacts. {5.3, 5.4, 5.7}

In order to stabilise the concentration of GHGs in the atmosphere, emissions would need to peak and decline thereafter. The lower the stabilisation level, the more quickly this peak and decline would need to occur.[20] {5.4}

[20] For the lowest mitigation scenario category assessed, emissions would need to peak by 2015 and for the highest by 2090 (see Table SPM.6). Scenarios that use alternative emission pathways show substantial differences in the rate of global climate change.

Table SPM.6 and Figure SPM.11 summarise the required emission levels for different groups of stabilisation concentrations and the resulting equilibrium global warming and long-term sea level rise due to thermal expansion only.[21] The timing and level of mitigation to reach a given temperature stabilisation level is earlier and more stringent if climate sensitivity is high than if it is low. {5.4, 5.7}

Sea level rise under warming is inevitable. Thermal expansion would continue for many centuries after GHG concentrations have stabilised, for any of the stabilisation levels assessed, causing an eventual sea level rise much larger than projected for the 21st century. The eventual contributions from Greenland ice sheet loss could be several metres, and larger than from thermal expansion, should warming in excess of 1.9-4.6°C above pre-industrial be sustained over many centuries. The long time scales of thermal expansion and ice sheet response to warming imply that stabilisation of GHG concentrations at or above present levels would not stabilise sea level for many centuries. {5.3, 5.4}

Table SPM.6. Characteristics of post-TAR stabilisation scenarios and resulting long-term equilibrium global average temperature and the sea level rise component from thermal expansion only. {Table 5.1}[a]

Category	CO_2 concentration at stabilisation (2005 = 379 ppm) [b]	CO_2-equivalent Concentration at stabilisation including GHGs and aerosols (2005 = 375 ppm) [b]	Peaking year for CO_2 emissions [a, c]	Change in global CO_2 emissions in 2050 (% of 2000 emissions) [a, c]	Global average temperature increase above pre-industrial at equilibrium, using "best estimate" climate sensitivity [d], [e]	Global average sea level rise above pre-industrial at equilibrium from thermal expansion only [f]	Number of assessed scenarios
	ppm	ppm	year	percent	°C	metres	
I	350 – 400	445 – 490	2000 – 2015	-85 to -50	2.0 – 2.4	0.4 – 1.4	6
II	400 – 440	490 – 535	2000 – 2020	-60 to -30	2.4 – 2.8	0.5 – 1.7	18
III	440 – 485	535 – 590	2010 – 2030	-30 to +5	2.8 – 3.2	0.6 – 1.9	21
IV	485 – 570	590 – 710	2020 – 2060	+10 to +60	3.2 – 4.0	0.6 – 2.4	118
V	570 – 660	710 – 855	2050 – 2080	+25 to +85	4.0 – 4.9	0.8 – 2.9	9
VI	660 – 790	855 – 1130	2060 – 2090	+90 to +140	4.9 – 6.1	1.0 – 3.7	5

Notes:

a) The emission reductions to meet a particular stabilization level reported in the mitigation studies assessed here might be underestimated due to missing carbon cycle feedbacks (see also Topic 2).

b) Atmospheric CO_2 concentrations were 379 ppm in 2005. The best estimate of total CO_2-eq concentration in 2005 for all long-lived GHGs is about 455 ppm, while the corresponding value including the net effect of all anthropogenic forcing agents is 375 ppm CO_2-eq.

c) Ranges correspond to the 15th to 85th percentile of the post-TAR scenario distribution. CO_2 emissions are shown so multi-gas scenarios can be compared with CO_2-only scenarios (see Figure SPM.3).

d) The best estimate of climate sensitivity is 3°C.

e) Note that global average temperature at equilibrium is different from expected global average temperature at the time of stabilization of GHG concentrations due to the inertia of the climate system. For the majority of scenarios assessed, stabilisation of GHG concentrations occurs between 2100 and 2150 (see also Footnote 21).

f) Equilibrium sea level rise is for the contribution from ocean thermal expansion only and does not reach equilibrium for at least many centuries. These values have been estimated using relatively simple climate models (one low resolution AOGCM and several EMICs based on the best estimate of 3°C climate sensitivity) and do not include contributions from melting ice sheets, glaciers and ice caps. Long-term thermal expansion is projected to result in 0.2 to 0.6 m per degree Celsius of global average warming above pre-industrial. (AOGCM refers to Atmosphere Ocean General Circulation Models and EMICs to Earth System Models of Intermediate Complexity.)

[21] Estimates for the evolution of temperature over the course of this century are not available in the AR4 for the stabilisation scenarios. For most stabilisation levels global average temperature is approaching the equilibrium level over a few centuries. For the much lower stabilisation scenarios (category I and II, Figure SPM.11), the equilibrium temperature may be reached earlier.

CO_2 emissions and equilibrium temperature increases for a range of stabilisation levels

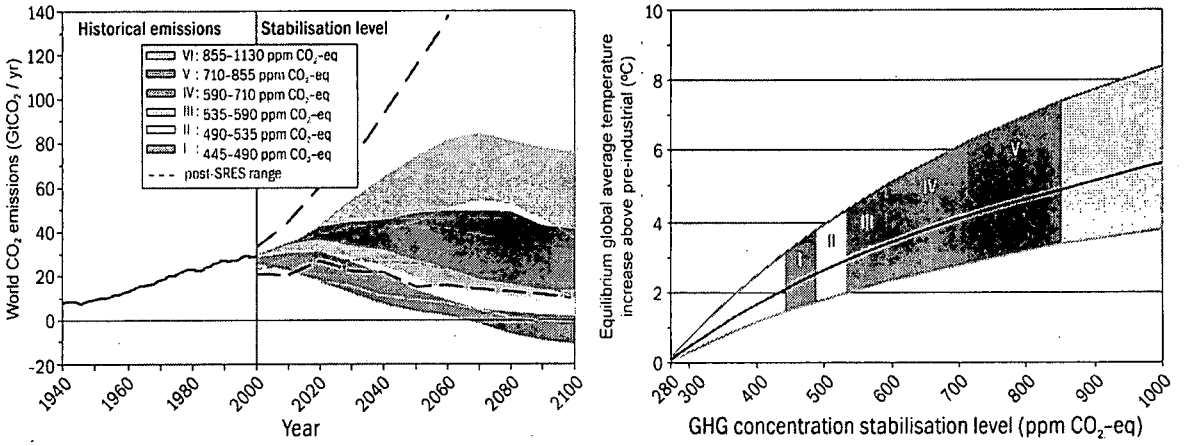


Figure SPM.11. Global CO_2 emissions for 1940 to 2000 and emissions ranges for categories of stabilisation scenarios from 2000 to 2100 (left-hand panel); and the corresponding relationship between the stabilisation target and the *likely* equilibrium global average temperature increase above pre-industrial (right-hand panel). Approaching equilibrium can take several centuries, especially for scenarios with higher levels of stabilisation. Coloured shadings show stabilisation scenarios grouped according to different targets (stabilisation category I to VI). Right-hand panel shows ranges of global average temperature change above pre-industrial, using (i) "best estimate" climate sensitivity of 3°C (black line in middle of shaded area), (ii) upper bound of *likely* range of climate sensitivity of 4.5°C (red line at top of shaded area) (iii) lower bound of *likely* range of climate sensitivity of 2°C (blue line at bottom of shaded area). Black dashed lines in the left panel give the emissions range of recent baseline scenarios published since the SRES (2000). Emissions ranges of the stabilisation scenarios comprise CO_2-only and multigas scenarios and correspond to the 10th-90th percentile of the full scenario distribution. Note: CO_2 emissions in most models do not include emissions from decay of above ground biomass that remains after logging and deforestation, and from peat fires and drained peat soils. {Figure 5.1}

There is *high agreement* and *much evidence* that all stabilisation levels assessed can be achieved by deployment of a portfolio of technologies that are either currently available or expected to be commercialised in coming decades, assuming appropriate and effective incentives are in place for their development, acquisition, deployment and diffusion and addressing related barriers. {5.5}

All assessed stabilisation scenarios indicate that 60-80% of the reductions would come from energy supply and use, and industrial processes, with energy efficiency playing a key role in many scenarios. Including non-CO_2 and CO_2 land-use and forestry mitigation options provides greater flexibility and cost-effectiveness. Low stabilisation levels require early investments and substantially more rapid diffusion and commercialisation of advanced low-emissions technologies. {5.5}

Without substantial investment flows and effective technology transfer, it may be difficult to achieve emission reduction at a significant scale. Mobilizing financing of incremental costs of low-carbon technologies is important. {5.5}

The macro-economic costs of mitigation generally rise with the stringency of the stabilisation target (Table SPM.7). For specific countries and sectors, costs vary considerably from the global average.[22] {5.6}

In 2050, global average macro-economic costs for mitigation towards stabilisation between 710 and 445ppm CO_2-eq are between a 1% gain and 5.5% decrease of global GDP (Table SPM.7). This corresponds to slowing average annual global GDP growth by less than 0.12 percentage points. {5.6}

[22] See footnote 17 for more detail on cost estimates and model assumptions.

Table SPM.7. Estimated global macro-economic costs in 2030 and 2050. Costs are relative to the baseline for least-cost trajectories towards different long-term stabilisation levels. {Table 5.2}

Stabilisation levels (ppm CO_2-eq)	Median GDP reduction [a] (%)		Range of GDP reduction [b] (%)		Reduction of average annual GDP growth rates (percentage points) [c], [e]	
	2030	2050	2030	2050	2030	2050
445 – 535 [d]	Not available		< 3	< 5.5	< 0.12	< 0.12
535 – 590	0.6	1.3	0.2 to 2.5	slightly negative to 4	< 0.1	< 0.1
590 – 710	0.2	0.5	-0.6 to 1.2	-1 to 2	< 0.06	< 0.05

Notes: Values given in this table correspond to the full literature across all baselines and mitigation scenarios that provide GDP numbers.

a) Global GDP based on market exchange rates.

b) The 10th and 90th percentile range of the analysed data are given where applicable. Negative values indicate GDP gain. The first row (445-535 ppm CO_2-eq) gives the upper bound estimate of the literature only.

c) The calculation of the reduction of the annual growth rate is based on the average reduction during the assessed period that would result in the indicated GDP decrease by 2030 and 2050 respectively.

d) The number of studies is relatively small and they generally use low baselines. High emissions baselines generally lead to higher costs.

e) The values correspond to the highest estimate for GDP reduction shown in column three.

Responding to climate change involves an iterative risk management process that includes both adaptation and mitigation and takes into account climate change damages, co-benefits, sustainability, equity, and attitudes to risk. {5.1}

Impacts of climate change are *very likely* to impose net annual costs which will increase over time as global temperatures increase. Peer-reviewed estimates of the social cost of carbon[23] in 2005 average US$12 per tonne of CO_2, but the range from 100 estimates is large (-$3 to $95/t$CO_2$). This is due in large part to differences in assumptions regarding climate sensitivity, response lags, the treatment of risk and equity, economic and non-economic impacts, the inclusion of potentially catastrophic losses, and discount rates. Aggregate estimates of costs mask significant differences in impacts across sectors, regions and populations and *very likely* underestimate damage costs because they cannot include many non-quantifiable impacts. {5.7}

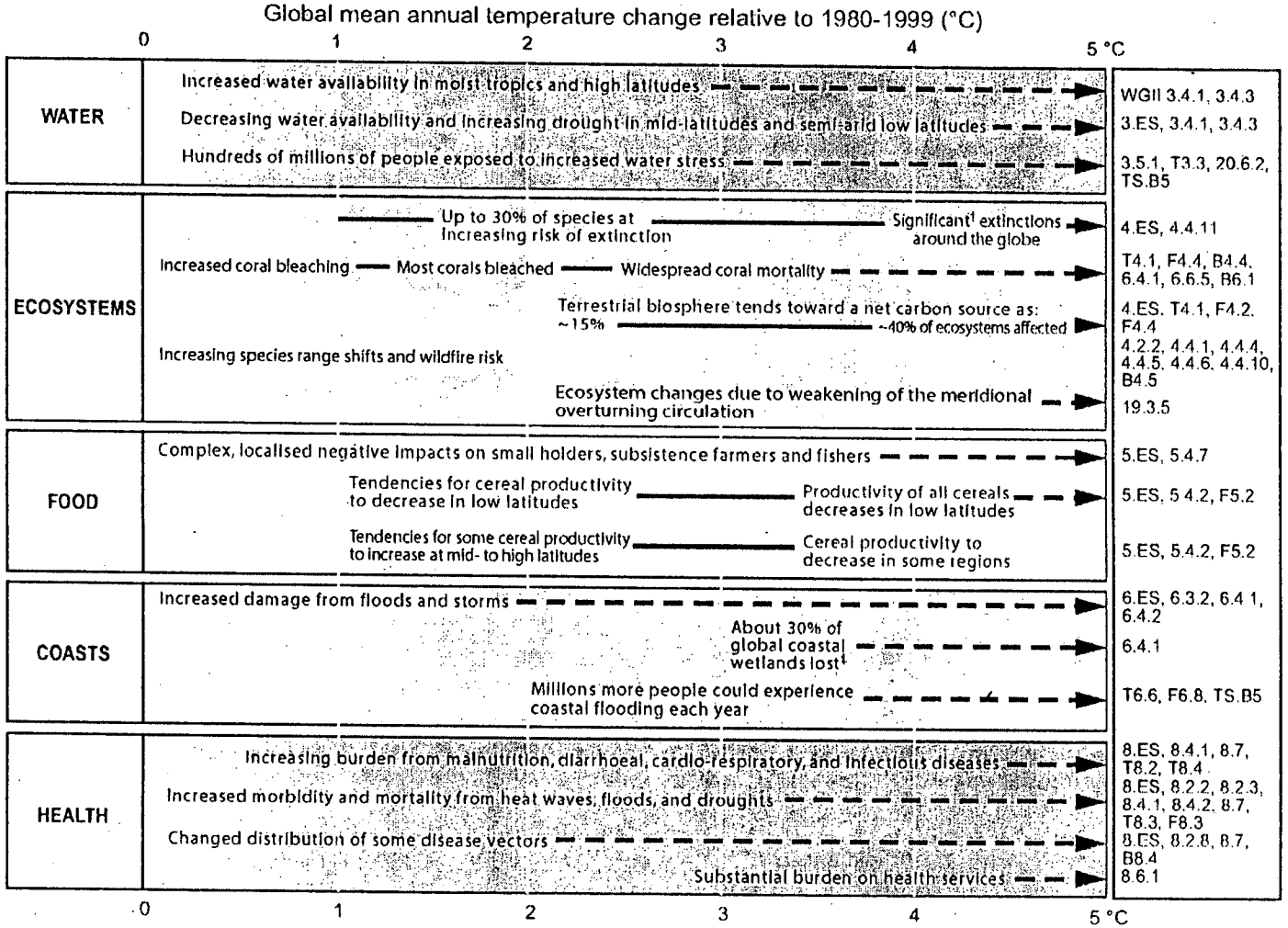
Limited and early analytical results from integrated analyses of the costs and benefits of mitigation indicate that they are broadly comparable in magnitude, but do not as yet permit an unambiguous determination of an emissions pathway or stabilisation level where benefits exceed costs. {5.7}

Climate sensitivity is a key uncertainty for mitigation scenarios for specific temperature levels. {5.4}

Choices about the scale and timing of GHG mitigation involve balancing the economic costs of more rapid emission reductions now against the corresponding medium-term and long-term climate risks of delay. {5.7}
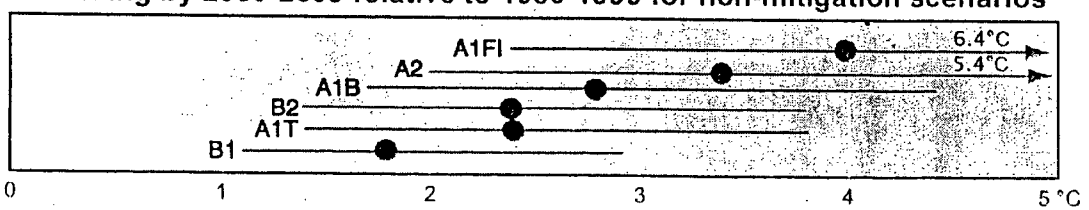
[23] Net economic costs of damages from climate change aggregated across the globe and discounted to the specified year.

Examples of impacts associated with global average temperature change
(Impacts will vary by extent of adaptation, rate of temperature change, and socio-economic pathway)



†Significant is defined here as more than 40%. ‡Based on average rate of sea level rise of 4.2 mm/year from 2000 to 2080.

Warming by 2090-2099 relative to 1980-1999 for non-mitigation scenarios



IPCC Fourth Assessment Report: Summary and Key Findings

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UNC Asheville

Report Organization

1. Observed changes in climate and their effects
2. Causes of changes
3. Impact projections – near and long term
4. Adaptation and mitigation as related to sustainable development
5. Adaptation and mitigation over the long term
6. Robust findings and key uncertainties

Uncertainty - 3 approaches*

- "qualitatively"
- "more quantitatively"
- "using expert judgement and statistical analysis"

*See introduction of "Longer Report" for full text

"more quantitatively"

- Confidence expressed as "chances in 10"
  - Very high 9 (or 90% chance or probability of 0.9)
  - High 8
  - Medium 5
  - Low 2
  - Very low <1

"expert judgement and statistical analysis"

■ Virtually certain	>99%
■ Extremely likely	>95% (or 96 – 99% certain)
■ Very likely	>90%
■ Likely	>66%
■ More likely than not	>50%

■ About as likely as not	33% – 66%
■ Unlikely	<33%
■ Very unlikely	<10%
■ Extremely unlikely	<5%
■ Exceptionally unlikely	<1%

1. Observed changes and their effects

1.1 "Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level."

1.1 Specific findings

- 11 of 12 warmest years ever recorded occurred from 1995 – 2006
- Warming greater at higher northern latitudes
- Land warming faster than ocean
- Rate of sea level rise increasing
  - Thermal expansion
  - Melting glaciers and ice caps

1. Observed changes and their effects

1.2 "Observational evidence from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature increases."

System effects

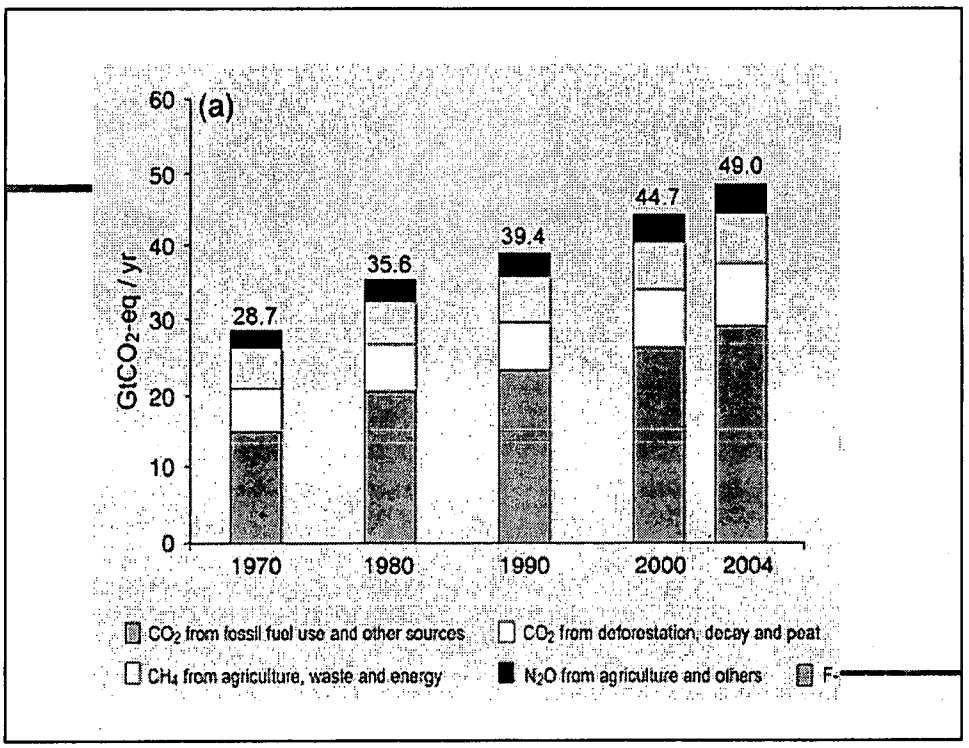
- *Very high confidence* terrestrial biological systems are strongly affected (e.g., earlier leafing, bird migration)
- *High confidence* marine and freshwater biological systems are affected (e.g., earlier fish migration)
- *Medium confidence* for effects on human-related systems (e.g., ag and forestry management, heat-related mortality, infectious disease vectors)

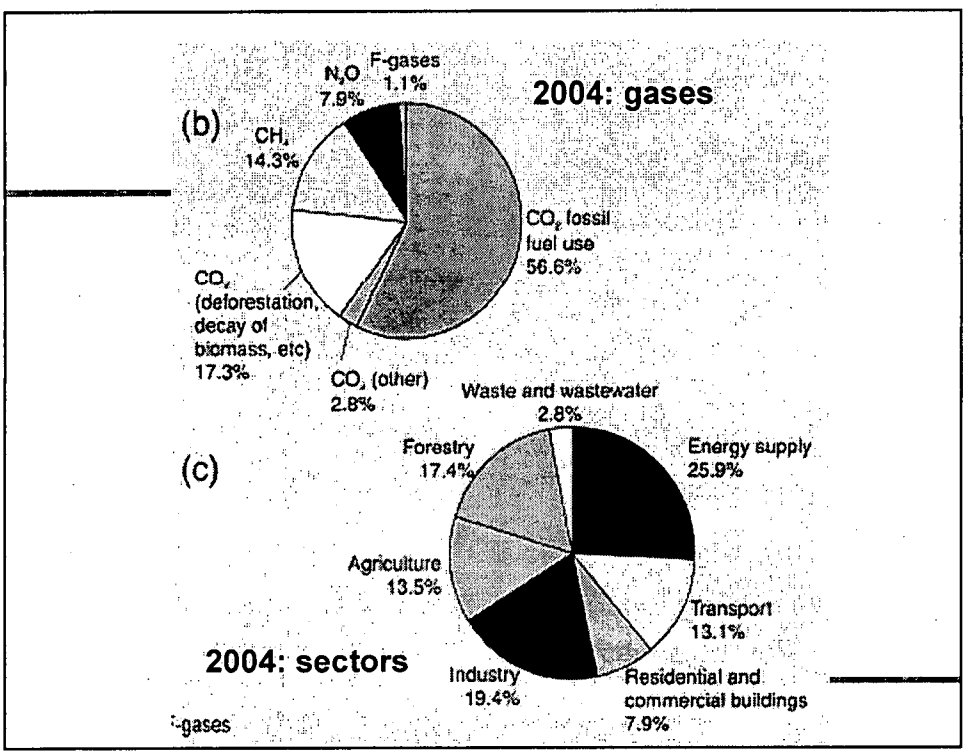
2. Causes of change

- Global GHG emissions from human activities have increased since pre-industrial times...
  - ...with an increase of 70% between 1970 and 2004, primarily from energy supply, transport and industry
  - Emissions from ag, buildings and forestry (including deforestation) increased at a lower rate

Global atmospheric GHG concentrations resulting from anthropogenic emissions

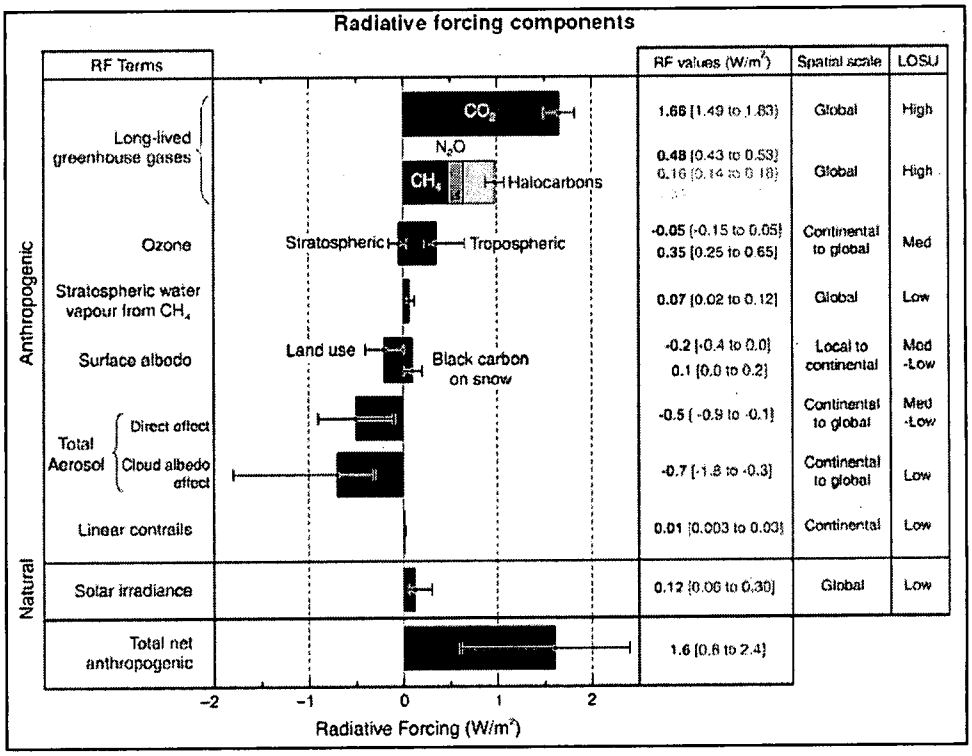
- Methane ($CH_{4)}$ and carbon dioxide ($CO_{2)}$ concentrations are higher than any time in last 650,000 years
- Nitrous oxide (N_2O) has increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values spanning many thousands of years

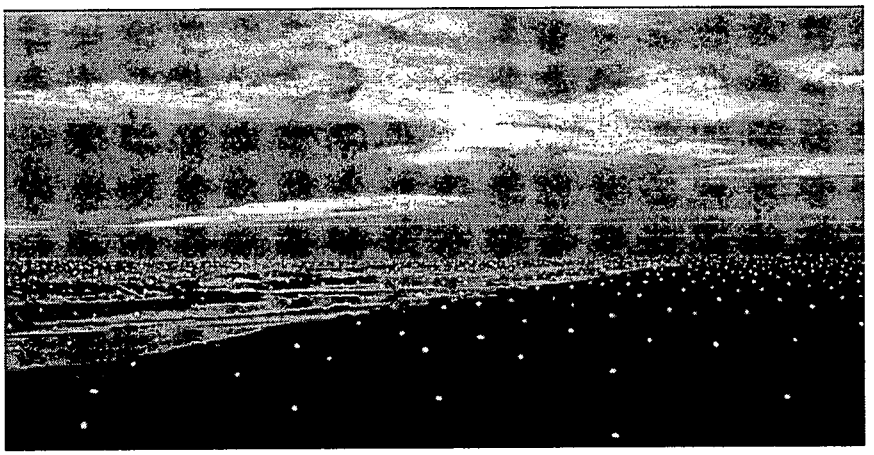

(a)
60
50
40
30
20
10
0
GtCO2-eq / yr
28.7
35.6
39.4
44.7
49.0
1970
1980
1990
2000
2004
CO2 from fossil fuel use and other sources
CO2 from deforestation, decay and peat
CH4 from agriculture, waste and energy
N2O from agriculture and others
F-


(b)
2004: gases
N2O 7.9%
F-gases 1.1%
CH4 14.3%
CO2 fossil fuel use 56.6%
CO2 (deforestation, decay of biomass, etc) 17.3%
CO2 (other) 2.8%
(c)
2004: sectors
Waste and wastewater 2.8%
Forestry 17.4%
Energy supply 25.9%
Agriculture 13.5%
Transport 13.1%
Industry 19.4%
Residential and commercial buildings 7.9%
F-gases

Effects

- There is *very high confidence* that the net effect of human activities since 1750 has been one of warming
- Warming of 0.2 °C (0.36 °F) per decade projected for next 2 decades
- Net effect due to human activities since the pre-industrial era are resulting in radiative forcing of +1.6 W/m2





3. Climate change impacts

- Assuming current climate change mitigation policies and related sustainable development practices, GHG emissions will continue to grow over the next few decades.

  ...but how will they grow?

6 Scenarios (assuming current policies and practices)

- 3 A1 scenarios assume
  - very rapid economic growth
  - mid-century population peak
  - rapid technology development
- A1FI = fossil intensive
- A1T = non-fossil intensive
- A1B = "balance" across all sources

Scenarios cont.

- B1 = same population as A1 with more rapid transition to service- and information-based economies
- B2 = intermediate population and econ growth, emphasizing local solutions to sustainability
- A2 = high population growth, slow economic development and slow technological change

Scenarios for GHG emissions from 2000 to 2100 in the absence of additional climate policies

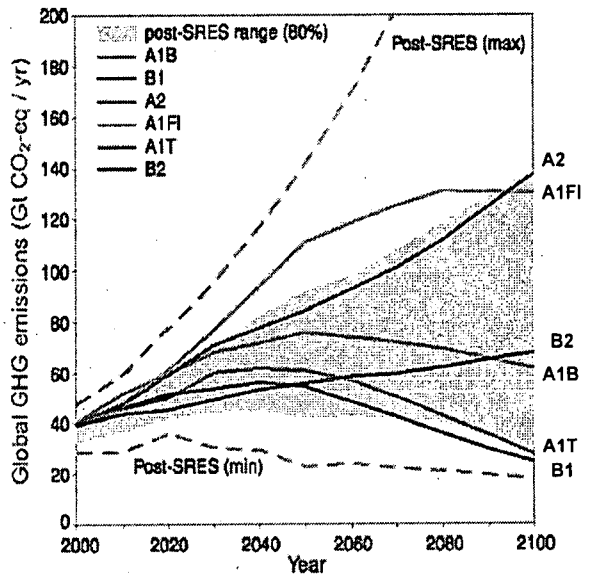
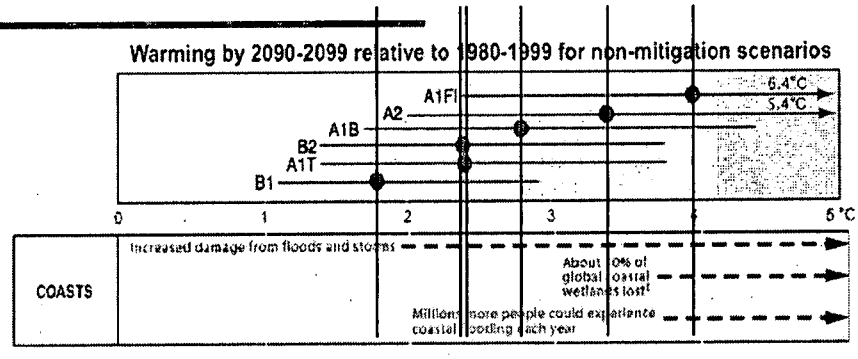


Figure 3.1. Global GHG emissions (in CO_2-eq per year) in the absence of additional climate policies: six illustrative SRES marker scenarios (coloured lines) and 80th percentile range of recent scenarios published since SRES (post-SRES) (grey shaded area). Dashed lines show the full range of post-SRES scenarios. The emissions cover CO_2, CH_4, N_2O, and F-gases. (WGIII 1.3, 3.2, Figure SPM.4)

- Note, previous graph is for <u>emissions</u>, not atmospheric GHG <u>concentrations</u> – which continue to rise under all above scenarios

	Temp change in °C (2090-99 relative to 1980-99)	Sea-level rise in m (same time period)
Case	Best estimate	Models exclude rapid changes in ice flow
Yr 2000 constant	0.6	Not available
B1	1.8 (3.24 °F)	0.18 – 0.38
A1T	2.4	0.20 – 0.45
B2	2.4	0.20 – 0.43
A1B	2.8	0.21 – 0.48
A2	3.4	0.23 – 0.51
A1FI	4.0 (7.2 °F)	0.26 – 0.59

Examples of impacts associated with global average temperature change

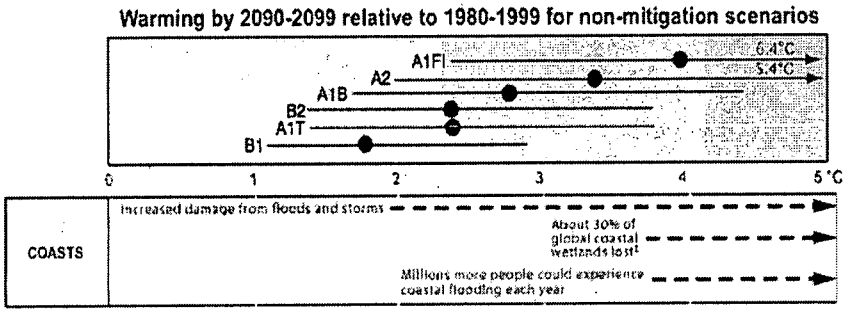


------ impacts continuing with increased temp

—— impacts are linked

Left hand side of text indicates temperature of impact onset

Impacts - Coast



Left hand side of text indicates temperature of impact onset

------- impacts continuing with increased temp

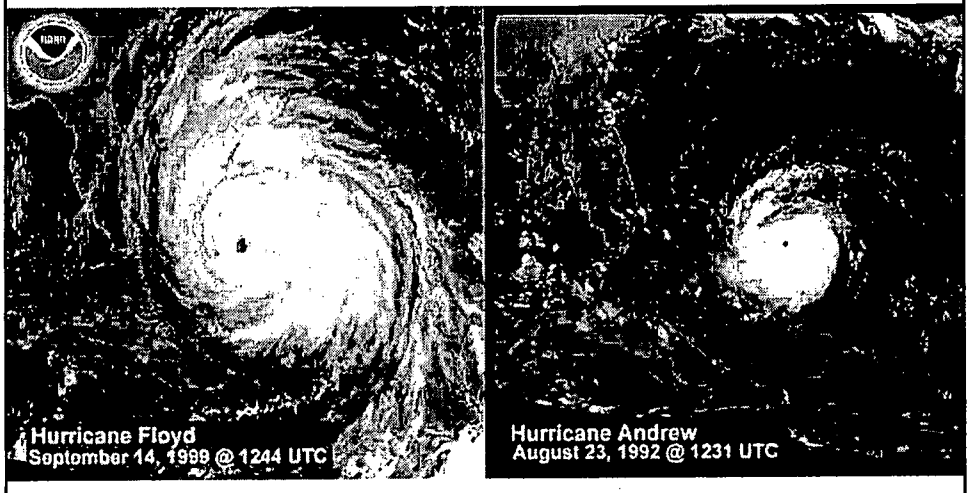
—— impacts are linked

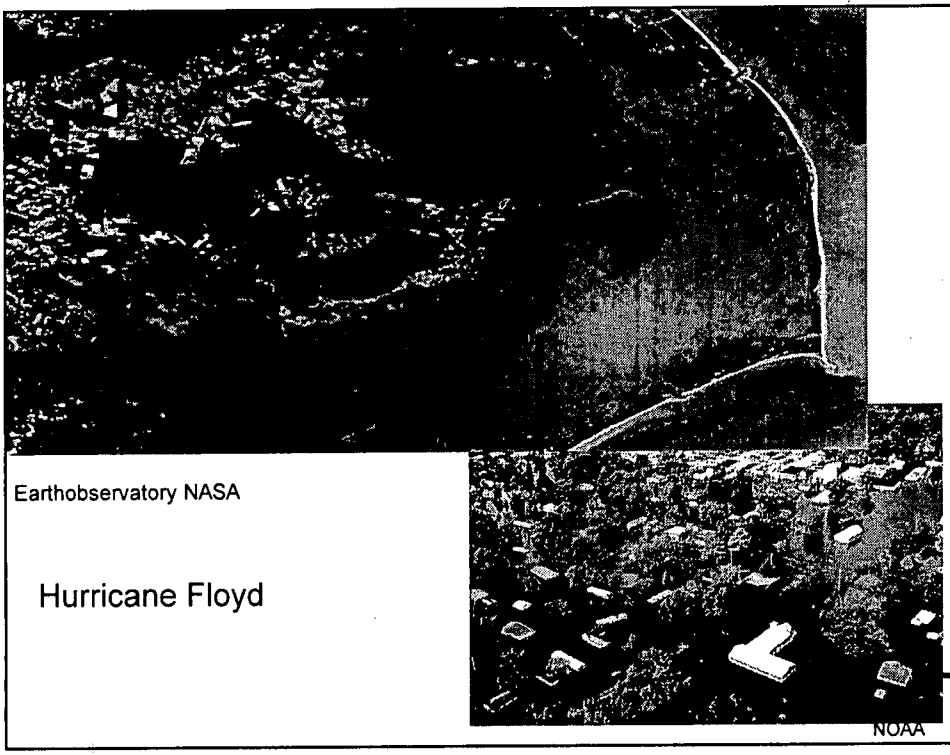
Likely increase in extreme high sea level



Appstate University

Possible increase in hurricane frequency and intensity

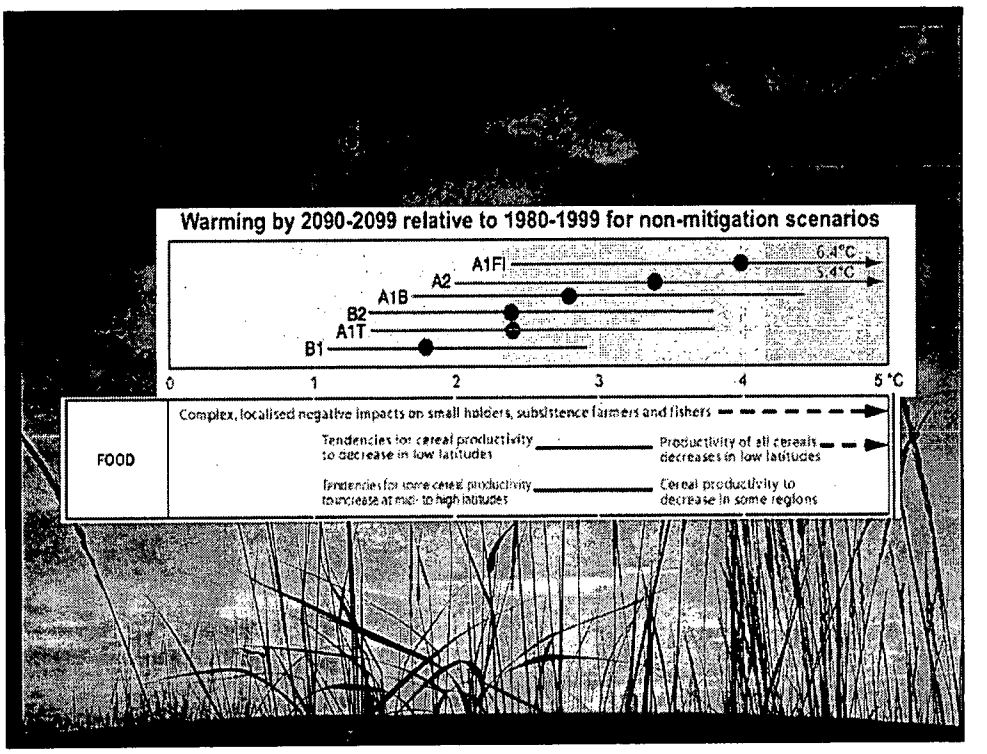




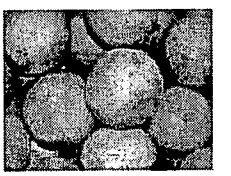
Earthobservatory NASA

Hurricane Floyd

NOAA



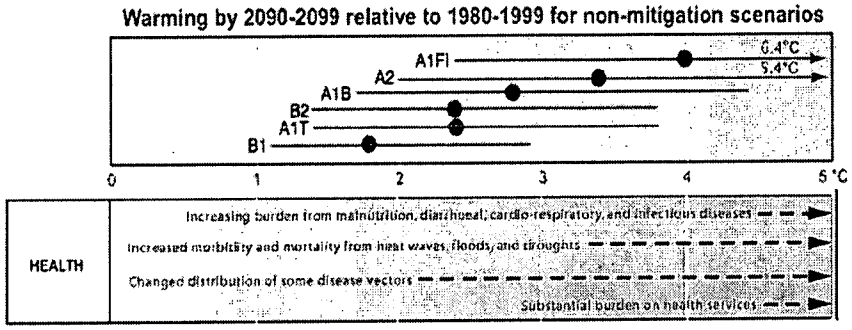
Other effects

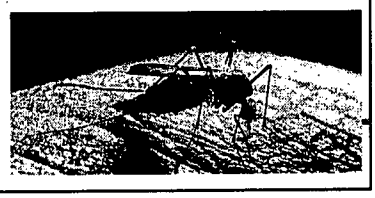


- shifts in areas suitable for various crops
- plant diseases
- plant pests
- animal diseases
- animal productivity
- crop productivity

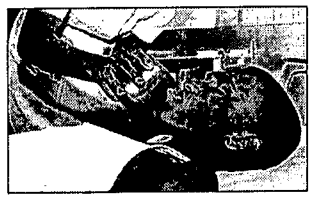


Impacts - Health

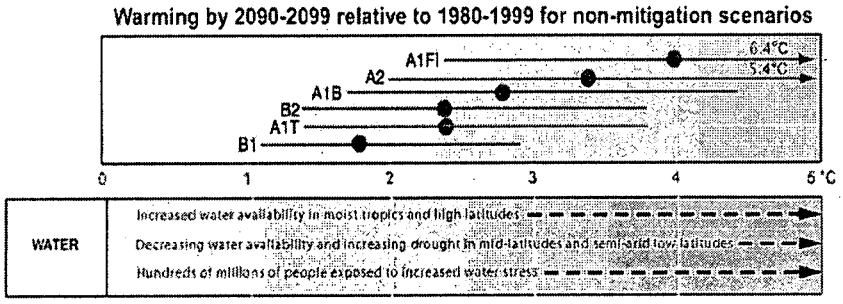




- *Likely increase* in heat waves



Impacts - Water



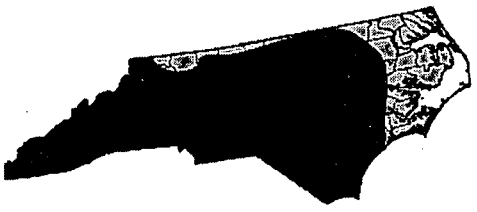
U.S. Drought Monitor

North Carolina

January 8, 2008
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.0	100.0	100.0	100.0	83.7	51.3
Last Week (01/01/2008 map)	0.0	100.0	100.0	100.0	83.7	51.3
3 Months Ago (10/10/2007 map)	0.0	100.0	100.0	100.0	84.6	54.3
Start of Calendar Year (01/01/2008 map)	0.0	100.0	100.0	100.0	83.7	51.3
Start of Water Year (10/02/2007 map)	0.0	100.0	100.0	92.8	79.4	37.7
One Year Ago (01/09/2007 map)	98.5	1.5	0.0	0.0	0.0	0.0



Intensity:

D0 Abnormally Dry
D1 Drought - Moderate
D2 Drought - Severe
D3 Drought - Extreme
D4 Drought - Exceptional

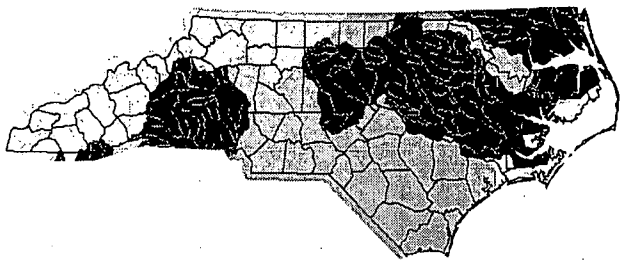
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements

http://drought.unl.edu/dm

USDA

Released Thursday, January 10, 2008
Author: Rich Tinker, CPC/NOAA

Likely increase in area affected by drought

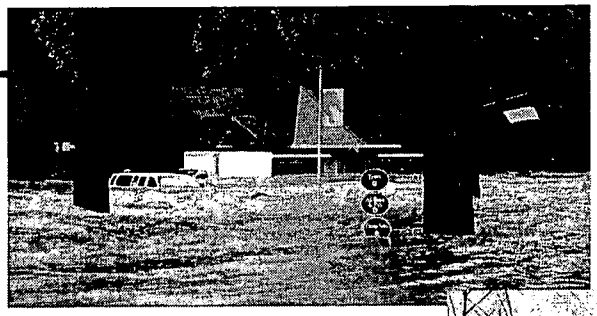


Stream flow - percentile classes

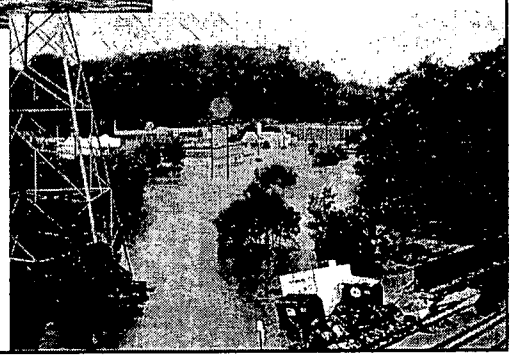
Low	<=5	6-9	10-24	Insufficient data
Extreme Hydrologic Draught	Severe Hydrologic Drought	Moderate Hydrologic Drought	Below normal	



Likely increase in heavy precipitation



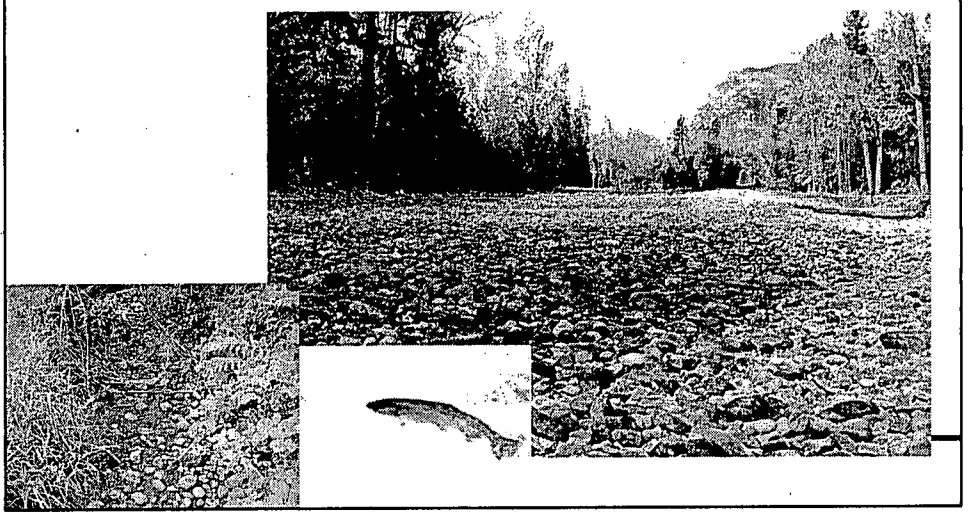
Entrance to Biltmore

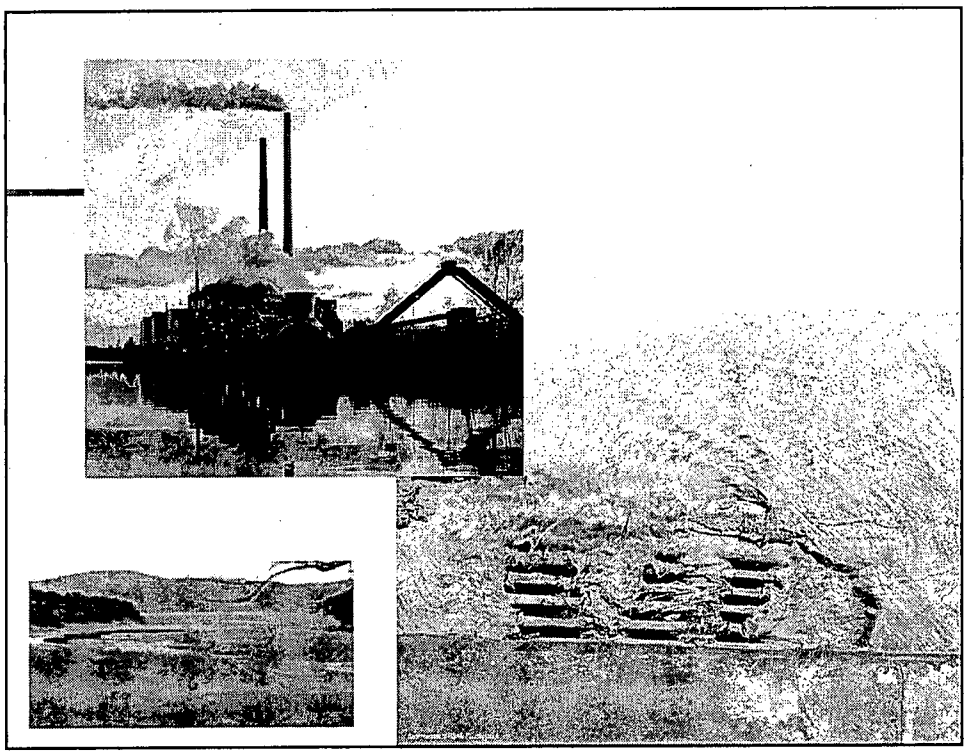


Remnant of hurricane Frances 2004 - flooding in Asheville, NC

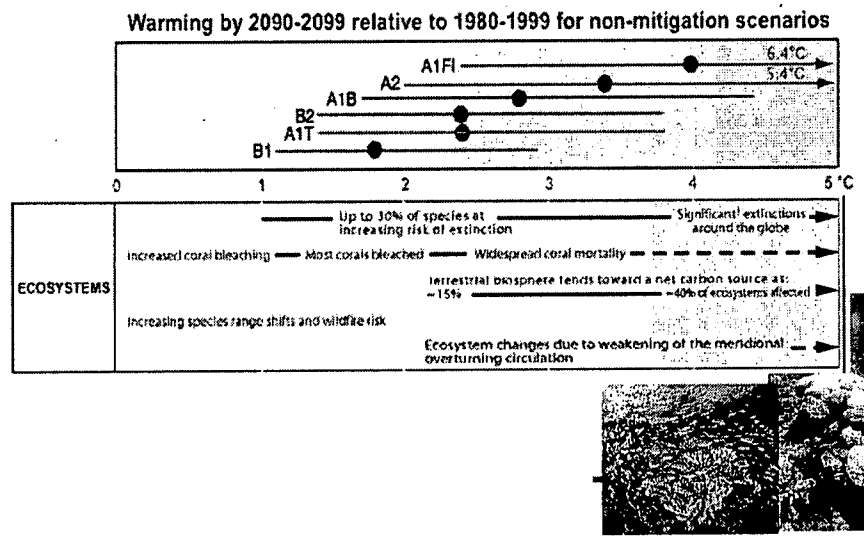
High confidence systems related to snow, ice and frozen ground are affected

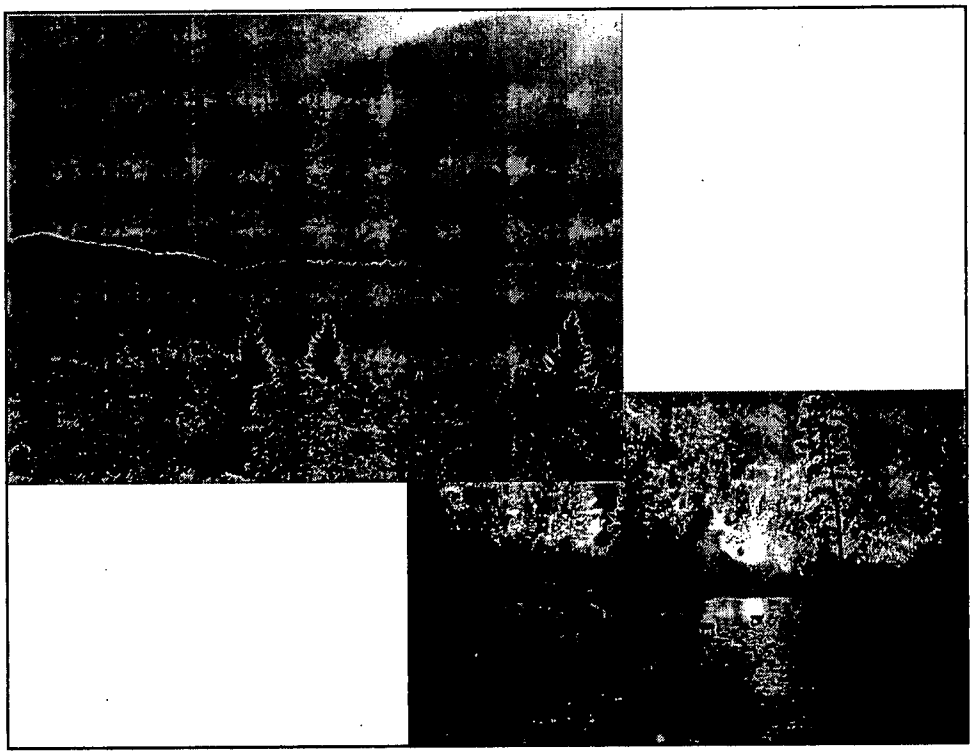
High confidence in increased runoff, earlier spring melting feeding snow- and glacier fed rivers, and warming of lakes



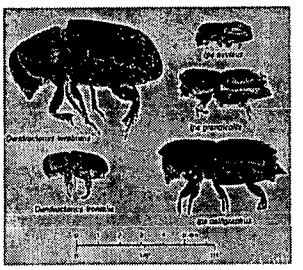


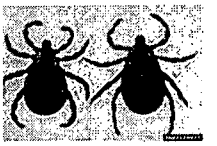
Impacts - Ecosystems





Very likely decrease in cold days and nights





Mitigation and adaptation

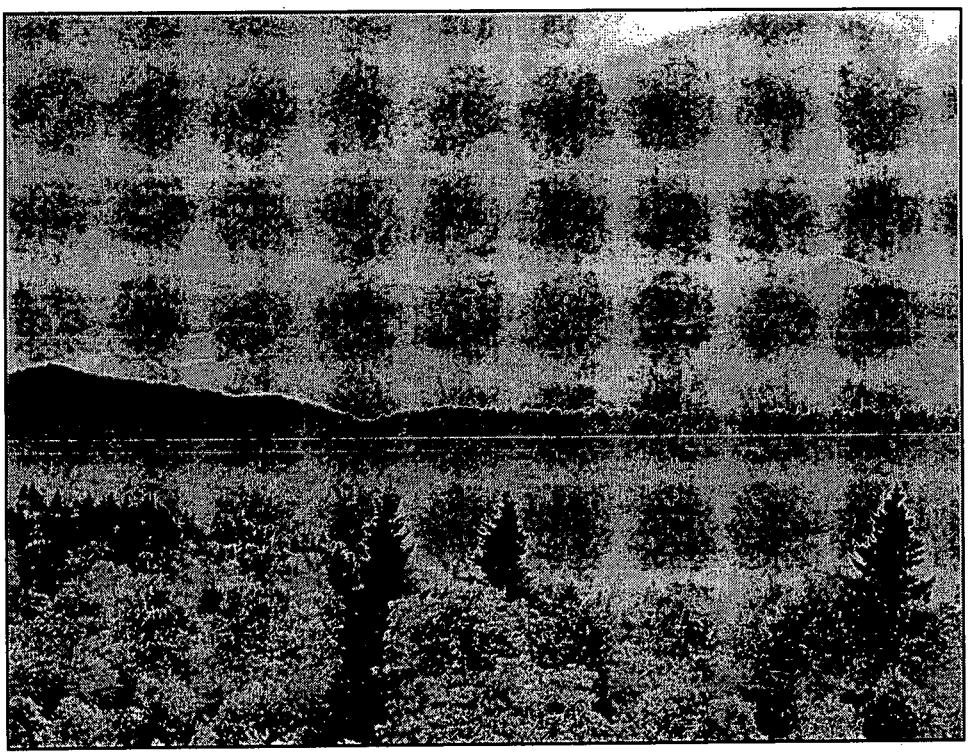
- More adaptation is required to reduce vulnerability to climate change
- A wide range of mitigation options are currently available and expected to be available by 2030 for all sectors with costs averaging $12 per ton CO_2

In a nutshell…

- Climate change is happening
- Humans are the primary cause
- It will result in extensive, possibly catastrophic negative effects if no action is taken
- It is possible to significantly reduce the impact on humans and non-human systems

Key actions to reduce impacts

- Reduce fossil fuel combustion
  - expand alternatives, increase generation and distribution efficiency, low carbon energy sources
- Increase efficiency
  - cars, buildings, industry
- Reduce agriculture and waste emissions
- Increase sequestration
  - soil, forests and forestry products, deep injection
- Adaptation



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The Intergovernmental Panel on Climate Change *Fourth Assessment Report*

The Intergovernmental Panel on Climate Change (IPCC), the world's most authoritative scientific body on the subject of global warming, was founded in 1988 at the request of the United States and the international community to assess the risk of human-induced climate change and to provide information needed by policymakers to inform and shape solutions to global warming. Each of the Panel's 2,500 scientists was nominated by their home government. The IPCC does not carry out new research, nor does it monitor climate-related data. Its periodic Assessment Reports, based on published and peer-reviewed scientific technical literature, are written to achieve the broadest possible consensus among Panel participants.

In 2007, the IPCC released its *Fourth Assessment Report* (AR4) on global climate change. The AR4 is organized into three Working Group Reports covering the science, impacts & adaptation, and mitigation. In November 2007, the IPCC released its synthesis report of the three individual parts. Below are the highlights from each.

Working Group I: The Physical Science Basis

The scientific literature reviewed by Working Group 1 (WG1) for its report "Climate Change 2007: The Physical Science Basis," significantly strengthened our understanding of two fundamentals. The WG1 report states:

- "Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and risking global mean sea level."
- With 91-95% certainty, the IPCC concluded that "Most of the observed increase in global average temperatures since the mid-20th century is *very likely*[1] due to the observed increase in anthropogenic greenhouse gas concentrations [emphasis in original]."

With regard to observed and projected temperature rise, the WG1 report found:

- Anthropogenic (human produced) greenhouse gas emissions have driven up global average temperatures by about 0.75°C during the last century.[2]
- Eleven of the last twelve years (1995–2006) rank among the 12 warmest years in the instrumental record of global surface temperature (since 1850).

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- Absent sharp near-term emissions reductions, global temperatures are estimated to increase by about 4°C (7.2° F), with the potential to go as high as 7°C (12.6° F) or higher.[3]

The Working Group I report also reported on important ocean and carbon-cycle issues:

- Increasing atmospheric carbon dioxide concentrations are causing a chemical change in the world's oceans, making the water more acidic. Acidification harms marine life forms like coral reefs, snails, and other organisms that are vital supports for the food chain.[4]
- Feedback mechanisms in the global carbon cycle will begin adding previously stored carbon to the atmosphere as the climate system warms. If emissions continue growing as they are now, CO_2 feedback is projected to increase global average warming in 2100 by more than 1°C (in addition to existing projections).

IPCC Working Group II: Impacts on North America and Summary for Policy Makers

The Working Group II report "Climate Change 2007: Impacts, Adaptation, and Vulnerability," released in April 2007, identified in far greater detail than earlier reports how global warming is currently affecting life on earth and projected future impacts.

The report stated that the comparatively small amount of warming that has already occurred is contributing "to the global burden of disease and premature deaths"[5] through temperature and precipitation changes, sea-level rise and the increasing frequency of extreme events.[6] Regarding future impacts, the IPCC says "For increases in global average temperature exceeding 1.5°C–2.5°C (2.7° F–4.5° F)[7] . . . there are projected to be . . . predominantly negative consequences for biodiversity, and ecosystem goods and services *e.g.*, water and food supply."[8] Higher levels of greenhouse gases will have a devastating human impact.

- By mid-century, more than a billion people will face water shortages and hunger, including 600 million in Africa alone.[9]
- Weather extremes, food and water scarcity, and climate-related public health threats are projected to displace between 150 million and 1 billion people as climate change unfolds.[10]

Damage to ecosystems and wildlife is projected to reach devastating levels.

- A 1.0°C increase in local temperatures at lower latitudes (especially seasonally dry and tropical regions) is projected to reduce crop productivity, which would increase risk of hunger [~5.4].
- Widespread coral mortality is expected with 2.0°C warming and higher.
- With a warming of 3.0°C and more, agricultural systems will begin to break down, causing a global decrease in food production potential. [5.4, 5.ES].
- With about a 4°C increase in global temperatures, more than 40% of known plant and animal species are projected to go extinct.[11]

Summary of Key North America Impacts:[12]

- Tens of millions of Americans are likely to face greater risks of injury and mortality due to higher pollution levels, more frequent and more intense heat waves, more intense storms, elevated pollen levels, and increased likelihood of water and insect-borne diseases.
- Western and Southwestern states, already facing increased water scarcity, are expected to experience inadequate and unreliable water supplies as snowpack diminishes and evaporation increases in both regions, with added stress in the Southwest caused by decreases in precipitation.
- North American forests face more destruction from the increasing incidence of wildfire, insect infestation, and disease. These disturbances could cost wood and timber producers between $1 billion and $2 billion a year during the 21st century.
- Coastal states face rising sea-levels accompanied by greater vulnerability to intense storms and storm surges, coastal erosion, and gradual inundation-effects that will also contribute to wetland losses. Storm impacts are likely to be more severe especially along the Gulf and Atlantic coasts, where any increase in destructiveness of coastal storms threatens significant loss of life and property damage.

Summary of Key Impacts around the World:[13]

- **Africa**: By 2020, between 75 million and 250 million people are projected to be exposed to increased water stress due to climate change. If coupled with increased demand, this will adversely affect livelihoods and exacerbate water-related problems.

- **Asia**: Glacier melt in the Himalayas is projected to increase flooding and rock avalanches from destabilized slopes, and to affect water resources within the next two to three decades. This will be followed by decreased river flows as the glaciers recede. Coastal areas, especially heavily-populated megadelta regions in South, East and South-East Asia, will be at greatest risk due to increased flooding from the sea and, in some megadeltas, flooding from the rivers.

- **Australia and New Zealand**: As a result of reduced precipitation and increased evaporation, water security problems are projected to intensify by 2030 in southern and eastern Australia and, in New Zealand, in Northland and some eastern regions.

- **Europe**: Nearly all European regions are anticipated to be negatively affected by some future impacts of climate change, and these will pose challenges to many economic sectors. Climate change is expected to magnify regional differences in Europe's natural resources and assets. Negative impacts will include increased risk of inland flash floods, and more frequent coastal flooding and increased erosion (due to storminess and sea-level rise). The great majority of organisms and ecosystems will have difficulty adapting to climate change. Mountainous areas will face glacier retreat, reduced snow cover and winter tourism, and extensive species losses (in some areas up to 60% under high emission scenarios by 2080).

- **Latin America**: By mid-century, increases in temperature and associated decreases in soil water are projected to lead to gradual replacement of tropical forest by savanna in eastern Amazonia. In drier areas, climate change is expected to lead to salinisation and desertification of agricultural land. Food security will be threatened by declining productivity of some important crops and livestock. Changes in precipitation patterns and the disappearance of glaciers are projected to significantly affect the availability of drinking water, as well as water for agriculture and energy generation.

- **Polar Regions**: The main projected biophysical effects are thinning and shrinking of glaciers and ice sheets and changes in natural ecosystems with detrimental effects on many organisms including migratory birds, mammals, and higher predators. In the Arctic, additional impacts include reductions in the extent of sea

ice and permafrost, increased coastal erosion, and an increase in the depth of permafrost seasonal thawing.

- **Small Islands**: Small islands, whether located in the tropics or higher latitudes, have characteristics which make them especially vulnerable to the effects of climate change, sea-level rise, and extreme events. Deterioration in coastal conditions, for example through erosion of beaches and coral bleaching, is expected to affect local resources, *e.g.*, fisheries, and reduce the value of these destinations for tourism. Sea-level rise is expected to exacerbate inundation, storm surge, erosion, and other coastal hazards, thus threatening vital infrastructure, settlements, and facilities that support the livelihood of island communities.

IPCC Working Group III: Mitigation

The Third Working Group Report, "Climate Change 2007: Mitigation," concluded that "there is substantial economic potential for the mitigation of global GHG emissions over the coming decades, that could offset the projected growth of global emissions or reduce emissions below current levels."[14]

The WGIII report lays out several climate stabilization scenarios. By stabilizing greenhouse gases at CO_2 equivalent concentrations of roughly 450-500 parts per million, global temperature rise could be limited to 2–2.4°C and sea-level rise due to thermal expansion to 1.4 meters.[15]

However, to limit the global temperature rise to these levels requires that global emissions peak by 2015 and decline to as little as 15% of 2000 levels by the year 2050.The IPCC estimates that doing so will reduce average GDP growth rates by less than 0.12 percentage points per year and notes that "Climate change policies related to energy efficiency and renewable energy are often economically beneficial, improve energy security and reduce local pollutant emissions." Other mitigation options can provide sustainable development benefits such as avoided displacement of local populations, jobs, and health improvement.The scientists found that, "In all analyzed world regions near-term health co-benefits from reduced air pollution as a result of actions to reduce GHG emissions can be substantial and may offset a substantial fraction of mitigation costs."

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Fortunately, the IPCC report makes clear that the tools needed to start reducing the threat of global warming are available now. "The stabilization levels assessed can be achieved by deployment of a portfolio of technologies that are either currently available or expected to be commercialized in coming decades." The WGIII report lists a wide range of technologies that are commercially available and could be used to immediately begin reducing emissions.Government and industry can collaborate on policies and practices that reduce emissions. Below are some ways each economic sector can contribute in to these stabilization goals.

- **Energy Supply**: Efficiency improvements, along with increased dependence on renewable energy sources and early applications of Carbon Capture and Storage (CCS) would considerably reduce emissions
- **Transportation**: Encouraging the production of more fuel efficient and hybrid vehicles is an easy way to limit emissions from the transportation sector.
- **Buildings**: Improved residential and commercial building standards, along with widespread implementation of passive and active solar design for heating and cooling would reduce the carbon dependency of buildings.
- **Industry**: More efficient end-use electrical equipment and heat and power recovery would improve industrial energy efficiency and help firms reduce energy costs. Materials recycling and substitution, and a wide array of process-specific technologies would also help reduce energy usage from this sector.
- **Agriculture**: Improved crop and grazing land management and restoration of cultivated peaty soils and degraded lands would increase soil carbon storage, while improved rice cultivation techniques and livestock and manure management would reduce methane emissions. This sector can also contribute alternative fuels with dedicated energy crops to replace fossil fuel use.
- **Waste Management**: Landfill methane recovery, waste incineration with energy recovery, and composting of organic waste are some of the options to reduce emissions and energy usage in this sector.

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[1] The IPCC explains that when the term 'very likely' is used, it means 91-95% certain.
[2] IPCC, Working Group I, "Summary for Policy Makers" (SPM), p. 5.

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[3] WGI, SPM, p. 13. The 4°C is the 'best estimate' of the temperature increase that will result from continued fossil-fuel intensive economic growth (the A1F1 scenario). In addition, the IPCC noted that carbon cycle feedbacks are likely to drive actual temperature increases even higher.
[4] WGI, Chapter 5.
[5] WGII, Chapter 8, p. 3.
[6] WGII, SPM.
[7] 2.7°F-4.5°F
[8] The statement asserts: "For increases in global average temperature exceeding 1.5-2.5°C and in concomitant atmospheric carbon dioxide concentrations, there are projected to be major changes in ecosystem structure and function, species' ecological interactions, and species' geographic ranges, with predominantly negative consequences for biodiversity, and ecosystem goods and services *e.g.*, water and food supply." WG III, SPM, p. 8.
[9] Intergovernmental Panel on Climate Change, Working Group II Assessment Report, Chapters 3 and 9.
[10] Sir Nicholas Stern, "Stern Review on the Economics of Climate Change," <www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_report.cfm>. See also Christian Aid, "Human Tide: The Real Migration Crisis," by, May 2007, <www.christianaid.org.uk/stoppoverty/climatechange/resources/human_tide.aspx>.
[11] WGII, "Chapter 4. Ecosystems, their properties, goods and services," p. 242, <http://www.ipcc-wg2.org/>.
[12] WGII, chapters 14 and 19.
[13] IPCC, WGII, Fourth Assessment Report, SPM
[14] WGIII SPM, p. 9.
[15] The IPCC specifies that this sea-level rise estimate excludes contributions from ice sheets, glaciers and ice caps, which are now known to be rapidly increasing the rate of sea-level rise and whose contributions could potentially raise sea-levels by many more meters.

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Topic 6 – Robust findings, key uncertainties

As in the TAR, a robust finding for climate change is defined as one that holds under a variety of approaches, methods, models and assumptions, and is expected to be relatively unaffected by uncertainties. Key uncertainties are those that, if reduced, could lead to new robust findings. {TAR SYR Q.9}

Robust findings do not encompass all key findings of the AR4. Some key findings may be policy-relevant even though they are associated with large uncertainties. {WGII 20.9}

The robust findings and key uncertainties listed below do not represent an exhaustive list.

6.1 Observed changes in climate and their effects, and their causes

Robust findings

Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level. {WGI 3.9, SPM}

Many natural systems, on all continents and in some oceans, are being affected by regional climate changes. Observed changes in many physical and biological systems are consistent with warming. As a result of uptake of anthropogenic CO_2 since 1750, the acidity of the surface ocean has increased. {WGI 5.4, WGII 1.3}

Global total annual anthropogenic GHG emissions, weighted by their 100-year GWPs, have grown by 70% between 1970 and 2004. As a result of anthropogenic emissions, atmospheric concentrations of N_2O now far exceed pre-industrial values spanning many thousands of years, and CH_4 and CO_2 now far exceed the natural range over the last 650,000 years. {WGI SPM; WGIII 1.3}

Most of the global average warming over the past 50 years is *very likely* due to anthropogenic GHG increases and it is *likely* that there is a discernible human induced warming averaged over each continent (except Antarctica). {WGI 9.4, SPM}

Anthropogenic warming over the last three decades has *likely* had a discernible influence at the global scale on observed changes in many physical and biological systems. {WGII 1.4, SPM}

Key uncertainties

Climate data coverage remains limited in some regions and there is a notable lack of geographic balance in data and literature on observed changes in natural and managed systems, with marked scarcity in developing countries. {WGI SPM; WGII 1.3, SPM}

Analysing and monitoring changes in extreme events, including drought, tropical cyclones, extreme temperatures, and the frequency and intensity of precipitation, is more difficult than for climatic averages as longer data time-series of higher spatial and temporal resolutions are required. {WGI 3.8, SPM}

Effects of climate changes on human and some natural systems are difficult to detect due to adaptation and non-climatic drivers. {WGII 1.3}

Difficulties remain in reliably simulating and attributing observed temperature changes to natural or human causes at smaller than continental scales. At these smaller scales, factors such as land-use

change and pollution also complicate the detection of anthropogenic warming influence on physical and biological systems. {WGI 8.3, 9.4, SPM; WGII 1.4, SPM}

The magnitude of CO_2 emissions from land-use change, and CH_4 emissions from individual sources remain as key uncertainties. {WGI 2.3, 7.3, 7.4; WGIII 1.3, TS.14}

6.2 Drivers and projections of future climate changes and their impacts

Robust findings

With current climate change mitigation policies and related sustainable development practices, global GHG emissions will continue to grow over the next few decades. {WGIII 3.2, SPM}

For the next two decades a warming of about 0.2°C per decade is projected for a range of SRES emission scenarios. {WGI 10.3, 10.7, SPM}

Continued GHG emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would *very likely* be larger than those observed during the 20th century. {WGI 10.3, 11.1, SPM}

The pattern of future warming where land warms more than the adjacent oceans and more in northern high latitudes is seen in all scenarios. {WGI 10.3, 11.1, SPM}

Warming tends to reduce terrestrial ecosystem and ocean uptake of atmospheric CO_2, increasing the fraction of anthropogenic emissions that remains in the atmosphere. {WGI 7.3, 10.4, 10.5, SPM}

Anthropogenic warming and sea level rise would continue for centuries even if GHG emissions were to be reduced sufficiently for GHG concentrations to stabilise, due to the timescales associated with climate processes and feedbacks. {WGI 10.7, SPM}

Equilibrium climate sensitivity is *very unlikely* to be less than 1.5°C. {WGI 8.6, 9.6, Box 10.2, SPM}

Some systems, sectors and regions are likely to be especially affected by climate change. The systems and sectors are some ecosystems (tundra, boreal forest, mountain, mediterranean-type, mangroves, salt marshes, coral reefs and the sea-ice biome), low-lying coasts, water resources in dry tropics and subtropics and in areas dependent on snow and ice melt, agriculture in low-latitude regions, and human health in areas with low adaptive capacity. The regions are the Arctic, Africa, small islands and Asian and African megadeltas. Within other regions, even those with high incomes, some people, areas and activities can be particularly at risk. {WGII TS.4.5}

Impacts are *very likely* to increase due to increased frequencies and intensities of some extreme weather events. Recent events have demonstrated the vulnerability of some sectors and regions, including in developed countries, to heat waves and tropical cyclones, flood and drought, providing stronger reasons for concern as compared to the findings of the TAR. {WGII Table SPM.2, 19.3}

Key uncertainties

Uncertainty in equilibrium climate sensitivity creates uncertainty in the expected warming for a given CO_2-eq stabilisation scenario. Uncertainty in the carbon cycle feedback creates uncertainty in the emission trajectory required to achieve a particular stabilisation level. {WGI 7.3, 10.4, 10.5, SPM}

Models differ considerably in their estimates of the strength of different feedbacks in the climate system, particularly cloud feedbacks, oceanic heat uptake, and carbon cycle feedbacks, although progress has been made in these areas. Also, the confidence in projections is higher for some variables

(e.g. temperature) than for others (e.g. precipitation), and is higher for larger spatial scales and longer time averaging periods. {WGI 7.3, 8.1-8.7, 9.6, 10.2, 10.7, SPM; WGII 4.4}

Aerosol impacts on the magnitude of the temperature response, clouds and precipitation remain uncertain. {WGI 2.9, 7.5, 9.2, 9.4, 9.5}

Future changes in the Greenland and Antarctic ice sheet mass, particularly due to changes in ice flow, are a major source of uncertainty that could increase sea level rise projections. The uncertainty in the penetration of the heat into the oceans also contributes to the future sea level rise uncertainty. {WGI 4.6, 6.4, 10.3, 10.7, SPM}

Large scale ocean circulation changes beyond the 21st century cannot be reliably assessed because of uncertainties in the meltwater supply from Greenland ice sheet and model response to the warming. {WGI 6.4, 8.7, 10.3 }

Projections of climate change and its impacts beyond about 2050 are strongly scenario- and model-dependent, and improved projections would require improved understanding of sources of uncertainty and enhancements in systematic observation networks. {WGII TS.6}

Impacts research is hampered by uncertainties surrounding regional projections of climate change, particularly precipitation. {WGII TS.6}

Understanding of low-probability/high-impact events, and the cumulative impacts of sequences of smaller events, which is required for risk-based approaches to decision-making, is generally limited. {WGII 19.4, 20.2, 20.4, 20.9, TS.6}

6.3 Responses to climate change

Robust findings

Some planned adaptation (of human activities) is occurring now; more extensive adaptation is required to reduce vulnerability to climate change. {WGII 17.ES, 20.5, Table 20.6, SPM}

Unmitigated climate change would, in the long term, be *likely* to exceed the capacity of natural, managed and human systems to adapt. {WGII 20.7, SPM}

A wide range of mitigation options are currently available or projected to be available by 2030 in all sectors, with the economic mitigation potential at costs that range from net negative up to 100 US$/tCO$_2$-equivalent, sufficient to offset the projected growth of global emissions or to reduce emissions to below current levels in 2030. {WGIII 11.3, SPM}

Many impacts can be reduced, delayed or avoided by mitigation. Mitigation efforts and investments over the next 2-3 decades will have a large impact on opportunities to achieve lower stabilisation levels. Delayed emission reductions significantly constrain the opportunities to achieve lower stabilisation levels and increases the risk of more severe climate change impacts. {WGII SPM, WGIII SPM}

The range of stabilisation levels for GHG concentrations that have been assessed can be achieved by deployment of a portfolio of technologies that are currently available and those that are expected to be commercialised in coming decades, provided that appropriate and effective incentives are in place and barriers are removed. In addition, further RD&D would be required to improve the technical performance, reduce the costs, and achieve social acceptability of new technologies. The lower the stabilisation levels, the greater the need for investment in new technologies during the next few decades. {WGIII 3.3, 3.4}

Making development more sustainable by changing development paths can make a major contribution to climate change mitigation and adaptation and to reducing vulnerability. {WGII 18.7, 20.3, SPM; WGIII 13.2, SPM}

Decisions about macro-economic and other policies that seem unrelated to climate change can significantly affect emissions. {WGIII 12.2}

Key uncertainties

Understanding of how development planners incorporate information about climate variability and change into their decisions is limited. This limits the integrated assessment of vulnerability. {WGII 18.8, 20.9}

The evolution and utilisation of adaptive and mitigative capacity depend on underlying socio-economic development pathways. {WGII 17.3, 17.4, 18.6, 19.4, 20.9}

Barriers, limits and costs of adaptation are not fully understood, partly because effective adaptation measures are highly dependent on specific geographical and climate risk factors as well as institutional, political and financial constraints. {WGII SPM}

Estimates of mitigation costs and potentials depend on assumptions about future socio-economic growth, technological change and consumption patterns. Uncertainty arises in particular from assumptions regarding the drivers of technology diffusion and the potential of long-term technology performance and cost improvements. Also little is known about the effects of changes in behaviour and lifestyles. {WGIII 3.3, 3.4, 11.3}

The effects of non-climate policies on emissions are poorly quantified. {WGIII 12.2}

Global Climate Change Commission
February 11, 2008
Room 3 McKimmon Center
North Carolina State University

Minutes

Co-Chair Representative Pricey Harrison called the meeting to order at 1:00 pm and welcomed all members of the commission and visitors. She then introduced George Givens, General Counsel, who reminded the members to sign and turn in their reimbursement forms. He informed them that were entitled to two days reimbursement for attending the Institute for Emerging Issues Forum being held at the McKimmon Center at North Carolina State University. He also went over the schedule of future meetings.

Mr. Givens also thanked the Institute for emerging Issues, especially Diane Sherry, for making this particular facility available to the commission and making arrangements for Dr. Pachauri to be available to speak to the commission. Mr. Givens reminded the commission that they are committed to getting Dr. Pachauri back to the forum in one hour. And with no further ado Mr. Givens said that "it is an honor to introduce Dr. Pachauri to you".

Please see the following page for Mr. Givens Introduction of Dr. Pachauri.

Dr. Pachuari:

Welcome members of the legislative commission on global climate change. I'm very grateful to you distinguished ladies and gentlemen for giving me this opportunity; to me this is like a homecoming. I'm an alumnus of NC State University and I owe a great deal to the state of North Carolina. I would say that the modest achievements that I have had really can be attributed to what I learned in this state, so thank you very much. It's a wonderful feeling to be back here and to talk to this distinguished group, which I'm sure will have much to do with the future of this state and of course the future of the world and the human race. I will run through some facts that come out of the IPCC fourth assessment report and without further ado. I will first give you a brief history of what we know about climate change. This is something that was essentially investigated by Swedish scientists more than 100 years ago, by the name of Dr. Henricus; who incidentally won the Nobel Prize for chemistry, I think in 1896, if I'm not mistaken. He calculated through a series of equations on what would happen to the climate of this earth if carbon dioxide increased in concentration in the atmosphere. And I must say a lot of these conclusions and findings have been drawn out by the realities instead. In 1988, as some of you honorable members would remember, was an extremely hot period where there was also extensive drought throughout North America. It was then that James Hanson, a very well known scientist who had been working on global climate change for a long time, appeared before the U.S. Congress and put forward the view that global warming is already happening. That created a lot of sensation, a great deal of stir all over the world and it was then that the UN General Assembly said that the IPCC should be established as a body to look into all aspects of climate change and carry out regular assessments in climate change. Fortunately this was not established to the UN body, it was established as an intergovernmental panel, where essentially decisions are taken by all the governments of the world and it's an autonomous body, even though it was established under the umbrella of the one (inaudible) organization and the United Nations environmental program. So it doesn't receive any funds from the U.N., it's not directly under the control of the U.N., it's an intergovernmental body where all the governments of the world take decisions of the basis of consensus and I must say in the twenty years of the existence of this body its had a remarkable record of being able to reach consensus. In my view if one establishes a tradition and a spirit of doing things in a particular way, as difficult as they may be, that essentially becomes a precedent for others to follow in the future. I think that's really been the case with the IPCC. In 1992 the U.N. framework convention on climate change was agreed to and in 1997 the Kyoto protocol came into existence, though of course it was not ratified and until its ratification it only a protocol that essentially existed on paper. 2005 was the warmest year since record keeping began in the mid-19th century and this was also the year when the Kyoto protocol went into effect, with the ratification by Russia, which essentially was the last country that was required to ratify, to give it the essential numbers that were required for ratification. Now the work of the IPCC as I mentioned, is guided by the mandate which was given by the (inaudible) organizations and its role is to assess on a comprehensive, objective, and transparent basis scientific, technical and socio-economic information relevant to understanding the scientific basis of climate change, its potential impacts, and the options for adaptation and mitigation. I want to emphasize that the IPCC by itself doesn't do any research, it mobilizes the best experts and scientists from all over the world and we carry our an assessment of climate change based on peer-reviewed literature, so everything that we look at and take into account in our assessments has to carry credibility of peer-reviewed publications, we don't settle for anything less than that. So essentially it is the work of the scientific community drawn from all over the world that provides us with the material for our assessment. The writing and review processes is very robust, very vigorous, we first have experts review the first draft of the report, then governmental experts review the second draft of the report and the draft a summary for policy makers. Then finally, governments review word by word the revised draft summary for policy makers and I might mention the policy war, the summary for policy makers is something that has to be approved by all the governments literally word by word. That causes very complex job, because you have diverse interests, diverse levels of expertise and know-how, but I must say, in the end, we do manage to arrive at the consensus.

Sometimes it can be a very painful and slow process by which we get agreement, but so far we have succeeded in getting it. Just to give you some facts, the fourth assessment report to the IPCC, which was completed last year culminating in the synthesis report which was released in November of last year, required and it won 2,500 scientific expert reviews. The (inaudible) contributing authors, these are people who provide inputs on their specific expertise. There are 450 lead authors. These are the people who actually do the writing. They came from over 130 countries. So it's clearly an undertaking of mammoth proportions and great complexity, but the good news is that we've been able to find agreement and find consensus for everything that is published in the end. One major finding that we had in the fourth assessment report was what is projected before you, that warming of the climate system is inequitable, its beyond any scientific doubt and it's something that is now very clear, because it's based on observations of increases in average air and ocean temperatures, the widespread melting of snow and ice, and rising average sea levels. The melting of snow and ice is something that is happening at a very rapid rate across the globe. For instance, I've been in the artic region myself and I've seen the kinds of changes that are taking place over there. Three weeks ago I was to go to Antarctica with the Norwegian Prime Minister; unfortunately with all the extensive travel I do I came with a bad attack of the flu and had to cancel the trip. I'm just itching to get there one of these days. I'll also be going to Greenland, where major changes are taking place. To give you a perspective over a period of time, let me mention that the warmth of the last half century is unusually increasing, at least in the last 1300 years and the last time the Polar Regions were significantly warmer than present for an extended period was 125,000 years ago. Reductions in polar ice (inaudible) 4-6 feet. I do want to emphasize however that when that warming took place 125,000 years ago the reasons were very different. That was essentially on account of changes in the position of the earth in relation to the position of the sun and that caused warming, significantly more than we have today. It's only to emphasize the fact that if we continue this warming for long periods of time, then clearly we could be facing the same risks that were faced by this planet 125,000 years ago. This is a chart of all the changes in global climate surface temperature that have taken place since industrialization began and you see these dots through which the line has been drawn, essentially to capture the changes that have taken place. There are ups and downs, as you will see, and that's largely because solar activity does influence the climate of this earth and there are some spots, the eruption of volcanoes, that has an impact on the climate of the earth, and of course human intervention through the increase in greenhouse gases in the earth's atmosphere. Now what is significant is period beyond the middle of the last century to where we are today and you will see that there has been a very rapid increase in temperature in this period. If you draw this line, covering a period of 100 years you would get a slope that gives you an increase of .074 degrees Centigrade/Celsius in this entire 100 year period, but if you look at the last 50 years you get a much, much steeper line which is equivalent to 0.128 degrees Celsius increase in temperature in this period. In other words, in the last 50 years the rate of increase of temperature has been higher than the rate of increase in the previous hundred year period. We also know that eleven of the last twelve years rank amount the twelve warmest years in the instrumental record of global surface temperature. We now have pretty firm observation, a great deal of data, on the basis which we can come to these conclusions on measurement of changes. This gives you the cumulative balance of glacier mass in different parts of the world. You will see there's been a shape decline in the size of the body of ice in these glaciers. Not such a susceptible change in the case off the glaciers in Europe and the Andes mountains, but elsewhere there's been a very rapid decline. This clearly means that if we look at the impact of this sea level rise, it can be substantial (inaudible) because all that mass of ice is flowing into the oceans and adding to sea level rise. This is a part of sea level rise and during the last century the increase in sea level has been about 17 centimeters, this is on the basis of actual measurements and our projections for this century are anywhere from 18-59 centimeters, but we're hesitant to place an upper limit on sea level rise because it's entirely possible that with rapid melting of the west Antarctic ice sheet and Greenland, these are large bodies of ice that are sitting on land, and if these were to collapse as a result of the rapid melting that is taking place over there, then we would have sea level rise of several meters. Now here again I might point out that global average sea level has risen since '61 at an average rate of 1.8 millimeters per year and since 1993

at 3.1 millimeters per year. Just to make the translation from metric numbers to the foot/pound system I mentioned that during the last century sea level rise has been 17 centimeters, that's pretty close to a foot in terms of increase, I would say about .75 or ¾'s of a foot in terms of increase in sea level. There are other changes in climates that are taking place which are well documented, for instance the extreme precipitation events. This is happening around the globe. You find that you get a large quantity of rain or snow in a short period of time which clearly causes some serious problems. There's been an increase in heat waves and of course the worst example, which I'm not (inaudible) human induced climate change, was what happened in 2003 in Europe, when around 20,000 people died in Paris and the surrounding areas. There have been changes in cyclonic activity and certainly an increase in drought as well as floods. If you look at the causes of change, there's been an substantial increase in the emissions of green house gases, carbon dioxide being the most prominent and also therefore as a consequence, substantial increase in the concentration of these gases. The atmospheric concentration of carbon dioxide in 2005 exceeds by far the maximum rate over the last 650,000 years. You might ask how do we tell what happened in this entire period of 650,000 years, fortunately science has reached a stage where through the drilling of ice cores in these large quantities of ice in the Antarctic region and elsewhere, we're able to pinpoint exactly when the ice was formed. We see air trapped in those little pieces of ice, that air, when analyzed, can tell you exactly what the carbon dioxide concentration was at that point in time, because when you get snowfall over perhaps millions of years, all that snow keeps coming down and newer layers keep mounting on it over a period of time. So it's relatively easy now for scientists to tell exactly to drill deep and to be able to pinpoint exactly the period when that ice was formed historically. Also, global greenhouse gas emissions have been on the increase in recent years due to human activities and their influence since pre-industrial time, substantially with an increase between 1970 and 2004. Now I just want to make an observation. I lived in this part of the world in the early 70s and I recall in 1973-74 when oil prices quadrupled worldwide after the out of oil wipe up. As some of you distinguished ladies and gentlemen would remember, that one had to stand in line early in the morning and get $3 or $5 worth of gasoline and I think all of that really had a major impact in bringing about major improvement in automobile efficiency. In fact I don't mind confessing to this distinguished audience, I had this youthful desire to buy a nice large luxury car and I bought a Roles 98 for almost a song, it cost me nothing and I drove it for almost a year and that's the only time when I've had an inefficient car to drive all over the place. The point I'm making is that soon after that there was a major one worldwide effort to bring about improvements in energy efficiency and that carried on until about 1985 or so, but then oil price crashed. As a matter of fact, I wrote a book which was published by John Hopkins University Press in 1985, in which I had projected an increase in oil prices in the future, but almost a week after the book was release oil prices crashed, with it the sales of my book. My only consolation was that I wasn't the only one who was wrong; there were several other, much bigger people, who made the same mistake. The point I'm making also is the fact that somehow we've lost site of the whole issue of energy security and all the other benefits that go along with it and we've been continuing to increase our emissions in the last 3 ½ decades. Now most of the observed increase in temperatures since the late 20th century is very likely due to the observed increase in natural progienic greenhouse gas concentration. Now this is a significant finding that we have come up with in the IPCC fourth assessment report and when we use the term "very likely" it represents the probability of over 90%. So in other words the warming that is taking place, since the middle of the 20th century is most probably the result of human use climate change. And CO2 annual emissions grow by about 80% between 1970 and 2004. So while green house gas emissions have grown 17% and carbon dioxide has been growing even faster, which means that we've been continuing to burn more and more fossil fuels. Now, if we look at causes of change, what you see over here is the result of climate models, which are very sophisticated, they run on very powerful computers these days and what began as a result is this grouping of projections for the past using only natural forcing. In other words only natural factors like solar activity, the eruption of volcanoes and so on, but if we run those models using both natural and anthropogenic forces, both natural as well as human factors, this is the kind of plot that we get for the 20th century. Now, if we were to compare this with the actual observations and this is

what we end up with. So the point I'm trying to make is that fortunately climate-modeling is now reached a level of reliability, where we have a very high level of confidence in what we are saying and what we are projecting for the future. Observed (inaudible) patterns of warming are only observed by models which include anthropogenic forces, so in other words, if you were to leave off the human factors and the human drivers of climate change, then I think we would be total wrong in coming up with projections of the future. We now know that continued emissions of greenhouse gases at or above concentrate to cause further warming and induce many changes in the global climate system during the 21st century and this will very likely be very larger than those observed during the 20th century. Now if we look at projections for the future what you find in this diagram is different shades of warming that we could project. For instance the darker shades represent high levels of temperature increase and the lighter shades are somewhat at the other end. It's interesting to observe that the highest warming is going to take this in the upper latitude of the northern hemisphere, that's where you'll get the darker shades. This is brought on by facts; even today the Arctic is warming at twice the rate of the rest of the globe and if you look at projections for the future this trend remotely intensifies. Now that again is going to cause problems because the Arctic region is going to lose a great deal of ice. I might also say that they might be other forms of tensions that would arise because shipping in the Arctic region will become almost an annual business. Its lot would be confined to two or three months of open sea routes and therefore it is likely to be a lot of competition for the resources in that region. The honorable members would know that some months ago Russia planted it's flag at the bottom of the North Pole which signifies the fact that they would want to get the resources over there but 25% of the hydro-carbon resources that have not been found yet in the world are supposed to lie in that region. So there's a lot of competition that's going to increase as a result, because shipping will become much easier. This clearly means that climate change is not going to be uniform, that there are some parts of the world that are going to be effected far more than others and I'm only talking about temperature changes at this point in time. In actual fact there are several other impacts that I would get into. Our projections for the future, for the end of the 21st century are that at the lower end of the scenarios that we can project we get a best estimate of 1.8 degrees Centigrade and at the upper end, about 4 degrees Centigrade, at the end of the 21st century. Now in the last century, and I just want to mention the exact temperature increase was about 0.74 degrees Centigrade. So if you were to combine that with even the 1.8 degrees Centigrade increase that would take place at the lower end of the scenarios, that gives you a total temperature increase of over 2.5 degrees, which is pretty serious. We also know that there could be a front of irreversible impacts. Partial melts of ice sheets from polar lands would imply several meters of sea level rise and this really means Greenland and the rest of Antarctic ice sheets. We've assessed a number of species in the IPCC and our assessment is that 20-30% of the species are likely to be at risk of extinction. Increases in warming exceed 1.5 – 2.5 degrees Centigrade. In North America, warming in western mountains is predicted to cause decreased snow pack and reduce summer flows, excavating competition for over allocated water resources, increased number, intensity, and duration of heat waves allow potential for adverse health impacts, and coastal communities and habitats will be increasingly stressed by climate change impacts interacting the development and pollution. So the coastal communities are particularly vulnerable to the impacts of climate change. One worry is that there are several populations which are going to be very vulnerable. The four (inaudible) that are more dependent on climate sensitive resources. The four in the world really don't have irrigation, they are dependent on rainfall. Their soil conditions cannot be improved through artificial means and they are therefore are dependent on that and a lot of their food, fiber and fuel comes from harvest and biomass. One vulnerability in Asia, Africa and Latin America is aggravated by other particle stresses and within other areas the poorer, modernized communities (inaudible) are particularly at risk and I might mention that even though I'm not connecting Hurricane Katrina with human induced climate change, the impacts of that particular event were particularly sever for the poorest communities in New Orleans for instance. Because they just didn't have the means by which they could have withstood this terrible happening and therefore what I'd like to emphasize is that the poorer, in a (inaudible) way they live, it could be poor countries or prosperous countries, they are certainly at a disadvantage. Now the fact that the Norwegian

nobility decided to give the Peace prize for 2007 to the IPCC and former Vice President Al Gore in some sense signifies the link that they saw between climate change and threats to stability in human security. Climate change could impact adversely basic human needs, access to food, access to water and stable health conditions. Coastal dentures are particularly vulnerable. This is a picture of most dentures in different parts of the world that would be highly vulnerable. The red ones are extreme cases, the brown dots are high cases and black dots are medium vulnerability. The most effected would be the mega-dentures in Asia, which includes cities like Shanghai, (inaudible) which have very high concentrations of populations, a great deal of property and infrastructure, all of which would be highly vulnerable in the case of coastal flooding. So these are areas that obviously would have to take some steps to adapt to this threat of climate change and their risks are expected to increase rapidly by coastal settlements (inaudible) increased risks above sea level rise. Agricultural activity at low latitudes are likely to suffer severe losses because of high temperature, drought, flood conditions, soil degradation. I can tell you on the basis of research that's been done in several developing countries, there's already a perceptible decline that's been measured, in years and productivity as a result of the impacts of climate change. Now this has implications for food security worldwide. Now our assessment is that there's a possible year reduction of 50% by 2020 in some African countries and these are countries that are already stressed with malnutrition and burdens of food supply, 30% possible year reductions by 2015 in Central and South Asia, 30% reduction by 2018 in Latin America. More significantly crop revenues could fall by 90% by the end of the century in Africa. Now when that happens, these communities will really have no choice but to move away from there and that represents a threat to security and peace in that region. So they would really not be able to carry out any of the agriculture with this drop in revenue that is likely to occur. Water availability is also likely to be affected, because of changes in precipitation factors, increases in (inaudible) of ground water, and glaciers melting, which would decrease river flows. The rates of people exposed to increased stress have been projected anywhere from 120 million to 1.2 billion in Asia by 2020, as early as that, 75-250 million in Africa by 2020, 16-24 million in Europe by 2017. Human health would be affected with these deaths, disease and injury, due to heat waves, storms, floods, fires and droughts. Increased frequency of cardio respiratory disease at higher temperature, increases in malnutrition and consequent disorders, increase (inaudible) disease, excavation of abundance and/or toxicity of cauldron. In general I might mention that (inaudible) diseases will increase because with higher temperatures a lot of organisms that carry disease will be able to thrive and perhaps multiply. Now may I submit that if one wants to look at the impacts of climate change in any area, it's absolutely essential that one carries out a study of the impacts specific to that particular region. In the case of North Carolina there's need to look at what might happen to coastal settlements, mountain ecology, human health, agriculture, and water resources, because if this research would be carried out in the next 2-3 years, I think this distinguished body would be in a much better position to recommend the kinds of adaptation that would be required. Because on a (inaudible) basis it's absolutely essential that adaptation has to be taken and even if you were to stabilize the concentration of greenhouse gases at current levels, climate change and it's impacts will continue for several decades and therefore there will be no choice but to adapt to the impacts of climate change over a period of time. For instance, if you were to stabilize the concentrations today, for the next two decades there would be a change in temperature of about 0.1 degrees Celsius over a decade. There's also a certain inertia in the energy system because you have power plants, you have a whole lot of infrastructure where you really can't bring about radical changes in the way you use and consume energy and therefore are locked into emission intensive infrastructure in developmental (inaudible) and therefore one has to plan out how one can bring about a transition, if we have to mitigate the emission of greenhouse gases. Choices about the skill and timing of greenhouse gas mitigation and I'm talking in the global level, involves balancing the costs of emission reduction against the (inaudible) delay. If we delay taking mitigation measures, then clearly the impacts of climate change would become more severe over time and leading to balance against what would be the implications of mitigation, that means producing greenhouse gases today. Now here is an important table and I'd like to draw your attention to the first row over here, which says that if you want to stabilize these greenhouse gas concentrations say between 445-

490 parts per million of CO2 equivalent, this will limit temperature increase to between 2 and 2.4 degrees Celsius, but if you're going to do that, then on the basis of our assessment CO2 emissions will need to peak by 2015, beyond which they will have to decline. But even with that, on account of global expansion alone, we would get sea level rise of 0.4-1.4 meters. So we're talking about roughly 1ft-4ft of increase in sea level as a result of thermal expansion alone. This doesn't take into account the melting of ice bodies at all. Now this is a pretty simple calculation. There are no uncertainties at (inaudible), because if you get this level of warming, then the oceans will become warmer. At the moment they haven't become warm all the way down to the lowest depths. It takes a long time for the oceans to warm, but when that happens then we get this level of sea level rise due to expansion alone. So mitigation efforts over the next two-three decades will have a large impact on our opportunities to achieve global stabilization. Hence if you want global stabilization levels in the future it's imperative that we start mitigation actions today. No looking beyond the (inaudible) the emission target to limit warming to 2-2.4 degrees Celsius would require developed countries to significantly reduce their emissions below 1990 levels or roughly 10-40% by 2020 and 40-95% by 2050. Developing country emissions need to deviate below their projected baseline within the next few decades. This means that developing countries will necessarily have to deviate from the path of growth of emissions that has been established by the developing countries, creating a very different future. However the good news is the cost of taking these actions is not high at all. We have assessed that if we look at the last line over here, to stabilize at 445-530 parts per million of CO2 equivalent, the costs to the world in 2030 will be less than 3% of the GDP, which amounts to 0.12% per annum and in 2050 it will be about 5.5% of the GDP. If we want to debate these two choices, lets say (inaudible) GDP without mitigation and assuming a steady rate of growth, this is what we would get. But with the stringent mitigation measures, this is the way that line of growth would actually deviate. And what does this amount to? This essentially means that the level of prosperity that the world would attain in 2030 would at best be postponed by 7 or 8 months or a year at the most. This is the price, the highest price that the world would have to pay, to avoid the impacts of climate change, which naturally could be substantially higher. This is the kind of choice that we need to grapple with. Stringent mitigation would postpone GDP growth of one year at most over the median term. There are a lot of co-benefits of mitigation, co-benefits from reduced air pollution, because when you, for instance reduce fossil fuel burning, there's also a benefit in terms of improved air quality at the local level, which has substantial health benefits. There would be increased energy security, much more rural employment, because perhaps one would deploy more decentralized systems for providing energy. There would be increased agriculture production and reduced pressure on (inaudible) ecosystem due to increased troposphere ozone concentrations. The co-benefits of mitigation are therefore offset a substantial fraction of mitigation costs. So while I talked about the 3% loss of GDP in 2030 if you really count all the other benefits that go with it then 3% would be easily wiped out. So in other words it could turn out to be a win-win situation because of higher energy security, local benefits in terms of lower pollution and therefore larger health benefits and so on. Now we've also found that all stabilizations, or stabilization levels assessed, can be achieved by department portfolio of technologies that are currently available or are expected to be commercialized in the upcoming decades. So we really don't have to wait for any major breakthroughs in new technology development. We can start this action of reducing emissions of greenhouse gases through mitigation with technologies that are already available to us. But this assumes that investment (inaudible) and technology transfer and incentive are in place for technology development. So you need a policy framework which would drive producers and consumers in that particular direction. What other kinds of policies and practices are required? Appropriate (inaudible) infrastructure developments, research development and demonstration, changes in lifestyle management practices, I recall I was teaching in the summer here when President Jimmy Carter came up, I'm sorry that wasn't in the summer, no it was in the winter that time, when he appeared at the Carnegie and I loaned double stacks and appealed to all Americans to do that. Now that's a change in lifestyle which I don't think represents any great loss of benefit but I want to give you a little anecdote which I'm sure I could share in confidence with this distinguished group. Three years ago I was invited to (inaudible) Leadership poll, by the Secretary of the

D.O.A. in Washington, D.C. I flew in that afternoon and there was a long line at immigration and by the time that I could get out, about an hour and a half had elapsed. There was a car that had been sent to receive me and this gentleman said "I thought you hadn't turned up, it's been a long time." I said "Well the immigration took a long time." He said "well, I've got a car for you, lets walk down there" we went along and this was a hot sunny day and I went there and I found the engine running and the air conditioner running. So I said "My God! Why did you have to do that?" and he said "Well I wanted you to step into a comfortable car." I said, "But you know, you probably had the engine for two hours. Was that really required?" So that's the kind of change in lifestyle that I'm talking about. It just means some attitude shifts, which when put together will really make an enormous difference. And that's what saying when (inaudible) practices, but what is absolutely critical is to provide an effective carbon price signal. None of this is going to happen unless we have a price on Carbon. If we had a price on Carbon, then the world would be invested in research and development, consumers would go in for a low carbon technologies and I think you can bring about a shift in the economy quite effectively. What I want to emphasize is that the world is moving towards a low carbon future. I mean you've heard some of the proposals that the European Union is considering, Japan is going to follow suit and this will happen in many other parts of the world, even in this country you have some states which are clearly taking proactive measures. Now the world therefore is going to be a low carbon world. Companies that they believe will meet with success in both business and society contexts and those that don't lag behind will suffer from losses in the market place and loss of reputation, because we'll be living in a globalize the world and I think that if we read the writing on the wall, then I think it would make a lot of sense to invest in those technologies that are going to lead to a low carbon future. Some countries have been smart, they are already doing that. I know for a fact that (inaudible) spoke today and he's a good friends and I didn't have a chance to say hello to him today, but you know he's investing in nuclear imagination, but he believes, as he said, "I'm investing because green is green" it means you have green bucks because you are investing in green technologies. DuPont has made a major commitment and there are several other such companies in the world, because they realize that is where business interests will lie in the future. (inaudible) nations that show commitment to the growing global consensus would also be interesting in the future. Everyone wants to be part of the global consensus and I think leadership in these areas would carry a great deal of prestige. And those that (inaudible) would certainly lose very little power and influence globally. So I think that these are realities that we must understand and finally on a philosophical note I think all of us have to understand that we as human beings are part of nature. As Chief Seattle said "Man did not weave the web of life, he is merely a strand in it. Whatever he does to the web, he does to himself." I think we need to understand that and if we do, then clearly all these actions are really going to be in support of the ecosystems of this planet and to the benefit of the conservation of natural resources on this planet. So with this I'd like to stop and take questions. Thank you very much.

FEMALE CHAIR:

Thank you Dr. Pachuri and thanks again for making the trip. We'll take questions if I could just invoke the chairs prerogative on (inaudible) presentation to address the skeptics reaction to the fact that developing nations that haven't yet achieved a level of industrialization that we have, and I'm wondering also were they fit into the 445 parts per million, if that calculates in there already take in some level of industrialization. If you could address that please.

Dr. Pachuri:

I think that's a very valid question, but I do want to point out a few facts. If you look at the developing countries and then look at their terms, they have substantially lower levels of emissions. I mean ranging from something like one ton per person per year, which compare to 20+ tons per person per year in North America. It's also true that there are 1.6 million people on the face of this planet that really

don't have access to modern forms of energy or electricity and I think that developing countries, politically there's a huge challenge, you really cannot say that we will cut down on the growth of emissions without serving these communities and these societies. It's also unfortunate, but true that every human being living in a developing country is so overload by the dream that is so much a part of lets say the American way of life. Everyone wants to buy a motorcar, everyone wants a refrigerator and how do you thwart their aspirations and ambitions and say "Look you guys can't have this, that's only meant for the developed countries" So it's a real dilemma, but having said so I must emphasize that in the developing countries there is a need to deviate from the path that's been pursued by the developed world. But how does one bring that about? I think there's a need for much greater technology (inaudible) there's also need for practicing what you preach. And I think some major (inaudible) and some measure of action to bring about improvements in efficiency, some reduction in emissions, and therefore fossil fuel use in these countries is vitally important. Otherwise there is this growing suspicion in the developing world and I talked to one of the leaders over there, that the developed countries don't want to do anything. I talked to the Chinese and they tell us "Look, we're supplying all the supermarkets, and all the department stores in the U.S. with goods and services that are being produced over here, obviously we're going to emit more." Now that's a very (inaudible) kind of argument and I do realize that it's a one-sided argument. On the other side, I mean China is now so focused on creating economic growth and development. I've been traveling to that country since 1981 and I can't recognize the place. In 1981 everyone used bicycles; everyone wore Mau suits, drab grey clothing, which had no style or elegance about it. May General Mau's soul rest in peace if they ever did, but the result was that they are now embarked on a path of development which is a clear explanation of what's being done in the developed world. You can't go around anywhere on the streets of Beijing because it's a parking lot. There are so many cars over there and they're flooding the market with millions and millions of cars. So it's a real dilemma and I don't know what one can do about it. I think we really have to work together. I think we need to come up with some clear result to bring about change in the developed country and perhaps work and assist the developing countries to move on a path that is distinctly different from what has been established in the developed countries of the world.

FEMALE CHAIR:

Thank you. I realize that our country has to play a much greater leadership role than we have in the past. Thank you for that. Mr. Chair do you have a question?

MALE CHAIR:

You have told us about the work of the IPCC today, in the fourth assessment report. What can you tell us about where the IPCC is going in the future?

Dr. Pachauri:

I think what we're doing is currently carrying out a detailed debate. As a matter of fact I've drafted a paper which I have sent to all the governments of the world, to all the authors of the fourth assessment report, and the (inaudible) of the IPCC, to carry out a detailed discussion and debate which will be culminated in April when we meet in the city of Budapest, to see what the IPCC should do in the future. We would be very sensitive to what governments feel we should do, because I think we've reached a stage where we need to look at our record in the past and what the expectation of the world are for the future and then come up with a plan of action. So I expect in the next few months we will have much greater clarity in response to that question.

Mr. Wilson:

Thank you madam chair. You mentioned several key areas where North Carolina could study our vulnerabilities to climate change. One of the frustrating things for us as state climatologist, my role is to provide some kind of guidance on this, that the global models don't do a very good job of simulating the climate in the past of in the Southeastern general part of North Carolina in particular. So it's very frustrating to give good guidance as to what might happen in the future. Given that, what strategy would you recommend for us to identify our vulnerabilities and give good guidance for the global models?

Dr. Pachauri:

I think that there are now quite a few regional models which with some adjustment of data can be used within a regional context. I would submit that in three or four models could be used one can come up with the consensus on what is most likely to happen. Of course having lived here, I know North Carolina is a very varied set of ecosystems reaching right from the coastal areas to the agricultural regions and of course the mountains. So one would have to see what the impacts would be on each of these ecosystems. My own belief is that in the next two years or so one could come up with a fairly comprehensible assessment of the impacts, at least enough to give us some policy prediction and guidance. But this means mobilizing some of the academic and research communities in the state and perhaps even outside rather quickly, to come up with results as soon as possible.

Dr. Eggers:

Thank you so much for being here. One thing that's frustrating to me when I see presentations like this for example, with your slide on economics is that it only went out to 2030 and I think many things about that; if we have a globe stabilizing greenhouse gas emissions and greenhouse gas concentrations in the atmosphere that's in the neighborhood of 500 or 700 parts per million, we're really condemning future generations to a life beyond understanding, in terms of the suffering that we are committing as (inaudible) and I hoping you're nodding in agreement to that, and so its frustrating to me to see that 2030 number and not see it go up 100 or 200 years for the correlation of what concentrations of greenhouse gas that would result in because if we are willing to condemn future generations and not (inaudible) them, I think we have impoverished the art of understanding already. Now I think this commission has a very profound responsibility and I think that as an environmental science professor that to talk about decreasing emissions and we need to talk about going carbon negative, if we're really going to be responsible about being stewards of the future and I wonder if you could talk about whether you think that's important and what we might do for that.

Dr. Pachuari:

First really, I submit that we've carried out assessment of tragedy is right to the end of this century and to be quite honest to go beyond that is really increasing the range of one's certainty. The reason why we focused on 2020 is because we feel that the global community must understand the urgency of action in the immediate future and also accept the fact that it's not expensive. I think our 2030 figure clearly establishes that. We also know that for the next 10-20 years irrespective of what scenario you pursue the increase in temperature would hardly vary, but where you really start seeing a difference and major deviation between the major scenarios and based on how much you stabilize that, it becomes much, much larger. Therefore I think it's critically important, and I agree with you entirely m'am, that we need to look at scenarios beyond 2030 and incidentally the fourth assessment report, perhaps for the first time, we've come up with a clearer linking and a clearing identification of temperature increases and the impacts that would occur with respect to water availability in terms of ecosystems, root security, so in other words its for the global community to decide whether 2 degrees centigrade is good enough or should it be lower. Now it really, and I always put this forward as a question, we thought more dangerous levels of climate

change were dangerous for whom? If you talk to the small island developing states, they tell you they've crossed that dangerous threshold, if you talk to people in Bangladesh, a country with a huge coastline and so low in terms of height of above see level, that a single cyclone, a single storm surge causes a enormous devastation, thousands of people die, so much property is destroyed in a densely populated country, so if you talk to these communities across the world, they'll tell you that we're living in a state of fear. We cannot accept temperature increase of even two degrees Celsius, that's a bit much. So I think we really need to look at our responsibility, not merely to future generations, I would say this very generation, because climate change is happening today, it's not something that's science fiction in the future and therefore what I would submit is that we should look at the cost of actions that we could take and those actions are really not all that expensive. I believe that it is well within the capacity of human society with the economic, the technological path that we have to bring about a transformation. Some countries that were protected and are a very modest example of (inaudible). They have taken very proactive steps to world renewal in forms of energy, they haven't lost terms, they have added terms as a result. The economy in the last two or three years has been doing much better than it ever did before. So it really in a sense provides you with opportunities and then by doing all this you will be able to bring down prices of oil in the global market; much of the huge money that is going into other parts of the world, which if I may say so within the confines of this room, is not really being used for human welfare in any part of the world. In fact it's being used in several cases to create dangers that they are all subject to. So I think there is a much larger focus in bringing about a major transformation and unless we start doing that today, we're going to really compound out problems into the future.

FEMALE CHAIR:

We have time for a couple more questions, but I did want to recognize a couple of distinguished guests we have in the audience today, Martin Riggor, who is the (inaudible) General in Atlanta. Thank you for coming and we have our distinguished Speaker of the House Joe Hackney with us today, former chair of this commission.

Dr. Smith: Dr. Pauchari, I appreciate you coming here with us. This commission has struggled with what we can do at the national level and state level. You have a global perspective on this and you put up some slides about part of the reduction goals for reduction. Can you talk about for just a minute to us about the importance of what we should be doing at a state level and possibly (inaudible) state level goals that are concurrent with what we need to be doing at the national level.

Dr. Pachuari:

I can only come up with some suggestions because I would really need to study the situation at the state, which was my home coincidently, before I could come up with something specific, but first thing I must mention, is that we must understand the impacts of climate change. I think the sooner we do that the better, because to create the infrastructure, to create the institutions, and the mechanisms, by we might be able to reduce the risks to life and property the better it will be. Secondly I will submit that this being an agricultural state it would make a lot of sense to look at options by which you could use large quantities of biomass to produce energy. Of course, also, we have to be very careful that it doesn't in any way, infringe the ability of the state to produce food and food grains, because that in my mind would be a great mistake. For there are several other technologies that the state could work on that would really provide win-win solutions. Finally, I think it's worth the while of legislature and the executive branch government in the state to look at means by which you could place a price on carbon. Now I do realize that its very difficult for one state to take such a step, because you have to compete with the rest of the world, but there might be means by which you could bring about a transition by gradual, because over a period of time actually speaking, it would give the producers of goods and services in the state and enormous advantage to be, to get the first advantage of moving in that direction. One would have to clearly see which industries are likely to be hit by such a measure and therefore you certainly don't want to have them run into serious problems but creating a signal by which they innovate, by which they start moving in that direction. I think one needs a set of fiscal policies by which you can move the state towards a lower carbon pattern of production and consumption. Finally, maybe worldwide thinking of some industries where you might even lay down some benchmark standards and regulate them. I mean the building sector is one sub-sector. In my old institute I didn't have a chance to go and do that as constructive building, one of which is a trading complex that uses more power from the grid. We've designed a building in such a way that the demand for energy is 1/3 of what it would be in a conventional building and all of it has been linked to what it would take and a biomass gasifier that generates power and they use the energy in the earth, where four meters below the surface of the earth the temperatures are uniform throughout the earth. So we've designed four (inaudible) through which it (inaudible) comes into living spaces that gives you cooling in the summer and heating in the winter. So you know, I think the building sector is one area where one can bring about changes in terms of benchmarks, in terms of building codes, and some rare conditions by which you can shift to a much more sustainable future. So I think these some of these measures, if one could evaluate them, provide a pretty strong program of action in this field.

Mr. Buffet:

Thank you Madame Chair. Thank you Dr. Pachuari for your clear answers. I want to ask the question and I only want to ask an analytical approach (inaudible). You put up the mitigation targets for the developed world in your slides, those create a range of debate both in the United States and (inaudible) and in this commission significantly strived for this goal for the state of North Carolina about what is enough for us to do? Each of those targets are 10-40 by 2010 and 40-95 by 2050, we have legislation in the United States Senate now that's in the middle of that. Some think it's not enough and so those of us who are trying to set goal and inspire some independent thinking about when do we act and when do we wait for a possibly even stronger program in the future? What would be your analytical approach here; what would be enough for this country to do in terms of action (inaudible)? How much do we need to act in the short term trying to wait two-four years and wait for a rosier picture.

Dr Pachuari:

I think that the U.S. has to be part of the next agreement, which is supposed to be is supposed to be finalized by the end of 2009. I would be very proud if this country took a leadership role. If the rest of

the world is going to accept a part of lets say 20%, then the U.S. can be brought to a new percent. I think that the county cannot lose as a result, because as I indicated earlier, if the world is really going to be a low carbon world then the U.S. is really has to be able to forefront, not only to provide model and political leadership, but also to take advantage of market opportunities that will grow in the future. I can assure you that let's say the world agrees to 20% carbon in the next agreement by 2009 it's entirely possible that four or five years down the road people may come up with more stringent topics. So you really need to lead by example and I would say that the legal (inaudible) from the U.S. administration have to engage fully in what is happening in the (inaudible) natural process and I'm glad at least that they are now part of (inaudible) natural process, because a year or two ago there was a kind of disdain or contempt for what was happening under the U.N. framework convention in climate change and I hope it changes even more in the future. So I think the U.S. has to be a part of the next agreement.

Co-Chair Representative Harrison asks if there any more questions. Representative Thomas offers a motion: "I would like to make a motion that essentially is as follows: that this body adopt a basic premise for future work that, number one, Global Climate Change is indeed real, and further, that human activity is a factor in that change, and with that, we can move forward on addressing some of the issues that we have discussed here today and in previous meetings."

Respectfully submitted,

Representative Pricey Harrison, Co-Chair, Presiding

Mr. John Garrou, Co-Chair

WMO

UNEP

Climate change

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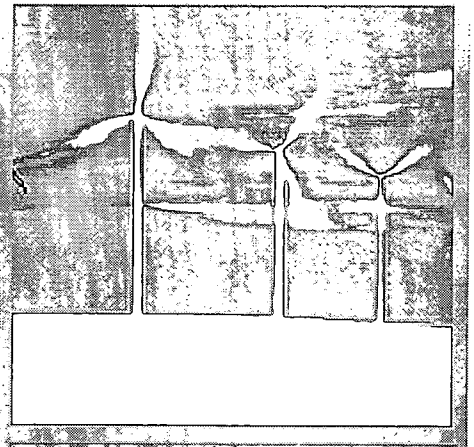
Key findings from the IPCC Fourth Assessment Report

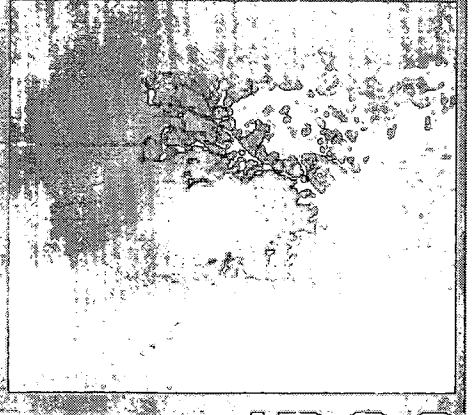


R. K. Pachauri

Chairman, IPCC

Director-General, TERI





Legislative Commission on Global Climate Change

Raleigh, 11th February 2008

IPCC

Introduction

History of climate change

1898: Swedish scientist Svante Ahrrenius warns carbon dioxide from coal and oil burning could warm the planet

1988: NASA scientist James Hansen tells U.S. Congress global warming "is already happening now"

Exceptional drought hits the USA

Creation of the IPCC

1992: UNFCCC aims at stabilising atmospheric concentrations of GHG

1997: UNFCCC parties approve Kyoto Protocol mandating emission cuts by industrial nations

2005: Warmest year since record-keeping began in mid-19th Century

Kyoto Protocol takes effect

The IPCC

The work of the IPCC is guided by the mandate given to it by its parent organisations: the World Meteorological Organisation (**WMO**) and the United Nations Environment Programme (**UNEP**)

Its role is to assess on a comprehensive, objective and transparent basis the **scientific, technical and socio-economic** information relevant to understanding the scientific basis of climate change, its potential impacts and options for adaptation and mitigation

The IPCC

Writing and review process

1. Experts review the first draft of the report

2. Governments and experts review the second draft of the report and the draft Summary for Policymakers

3. Governments review word-by-word the revised draft Summary for Policymakers

The IPCC

The Fourth Assessment Report (2007)

+2500 scientific expert reviewers

800 contributing authors

450 lead authors

+130 countries

Warming of the climate system is unequivocal, as is now evident from observations of increases in average air and ocean temperatures, widespread melting of snow and ice, and rising average sea level

Observed changes in climate

Paleoclimatic perspective

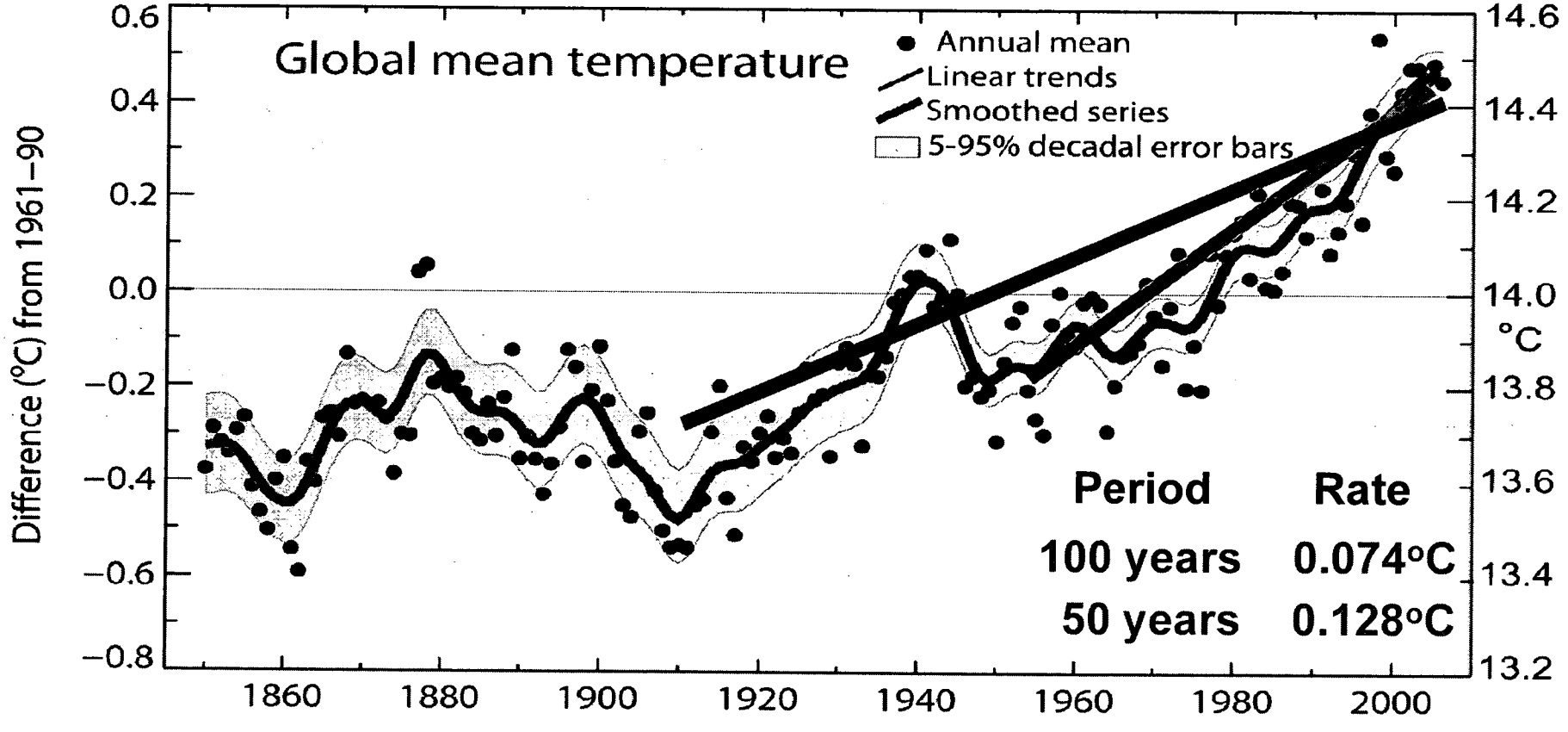
The warmth of the last half century is unusual in at least the previous **1,300 years**

Last time the polar regions were significantly warmer than present for an extended period (about 125,000 years ago), reductions in polar ice volume led to **4 to 6 m of sea level rise**



Observed changes in climate

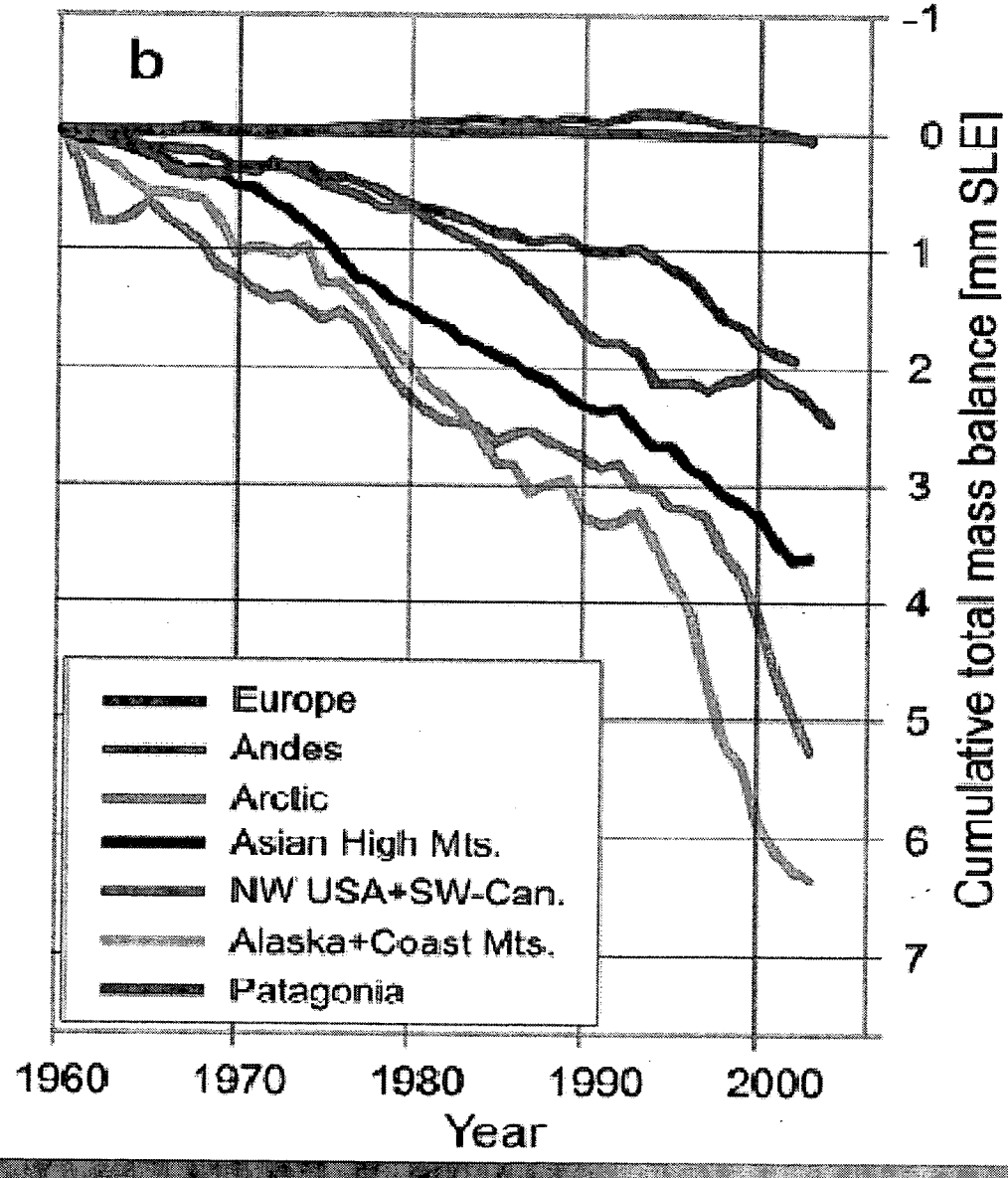
Changes in global average surface temperature



Eleven of the last twelve years rank among the twelve warmest years in the instrumental record of global surface temperature

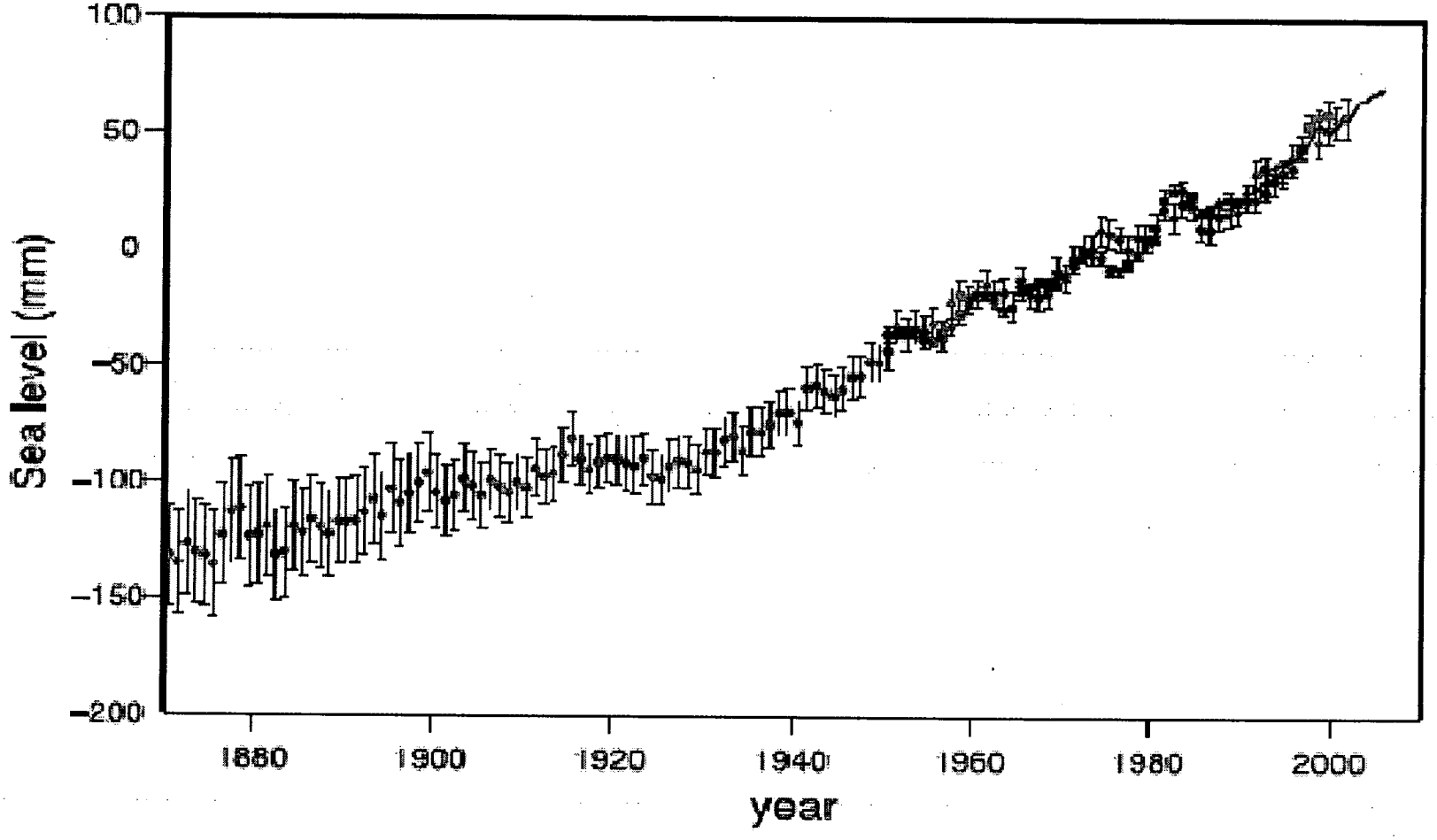
Observed changes in climate

Cumulative balance of glacier mass



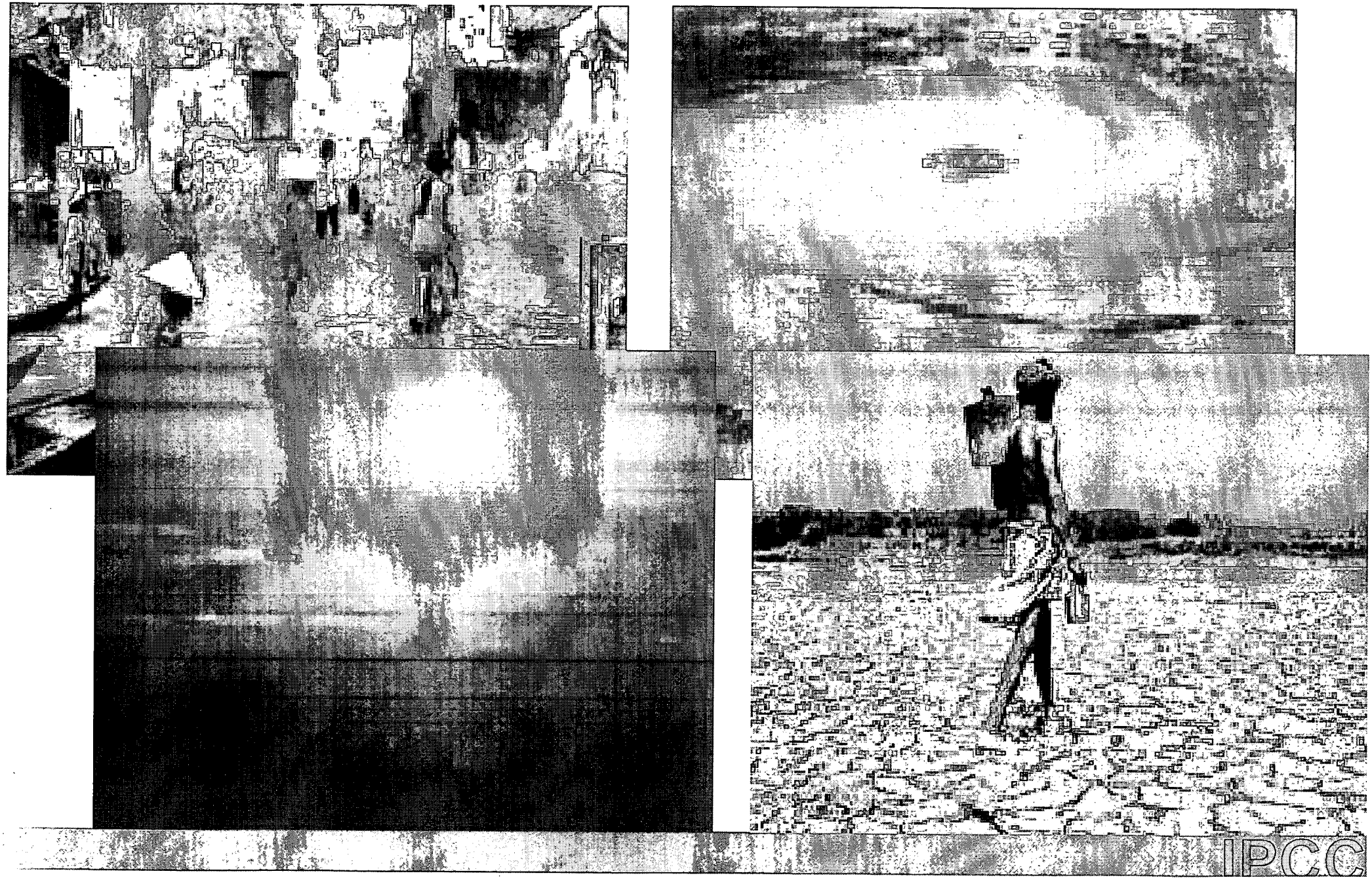
Observed changes in climate

Changes in global average sea level



Global average sea level has risen since 1961 at an average rate of 1.8mm/yr and since 1993 at 3.1mm/yr

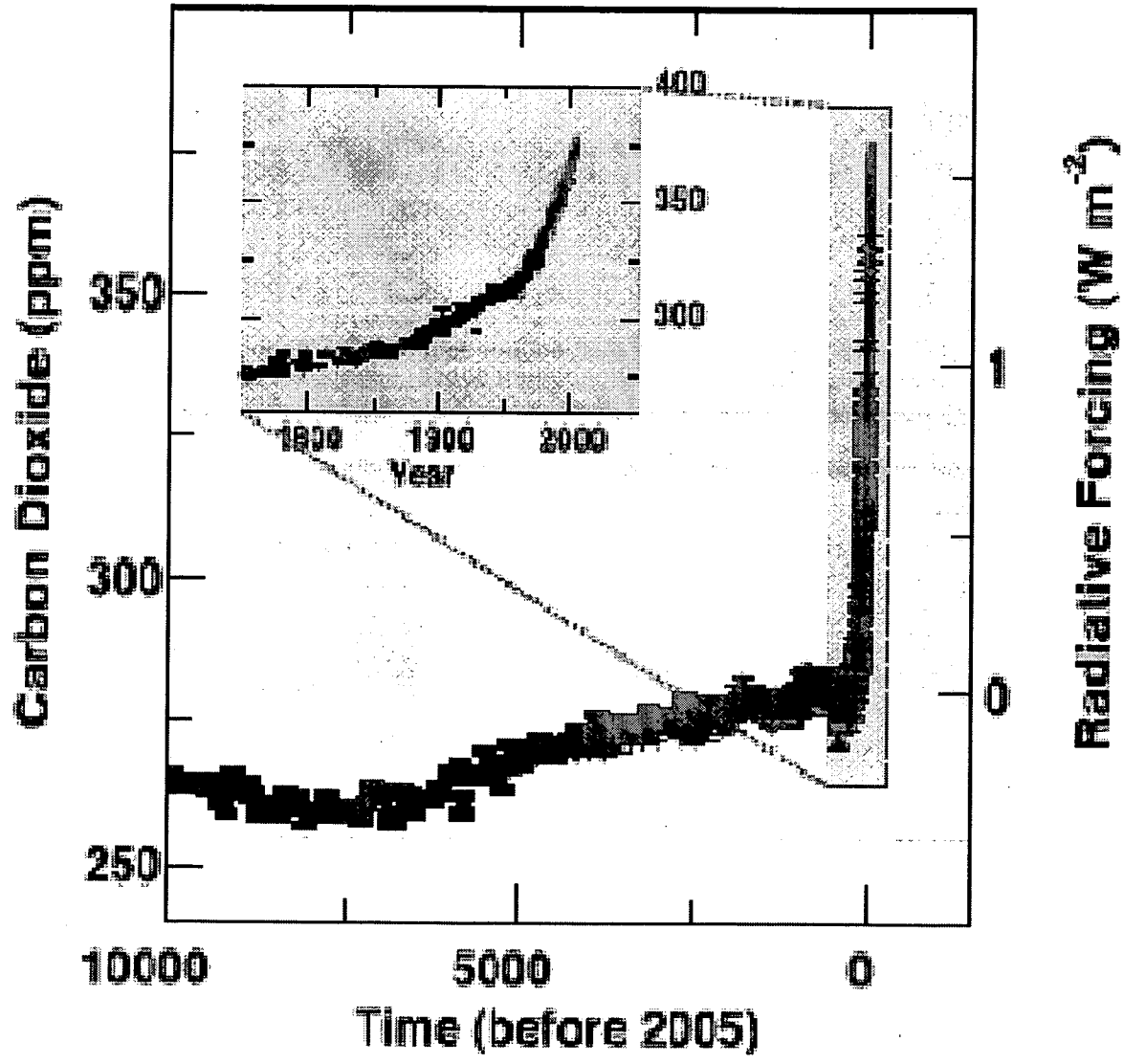
Observed changes in climate



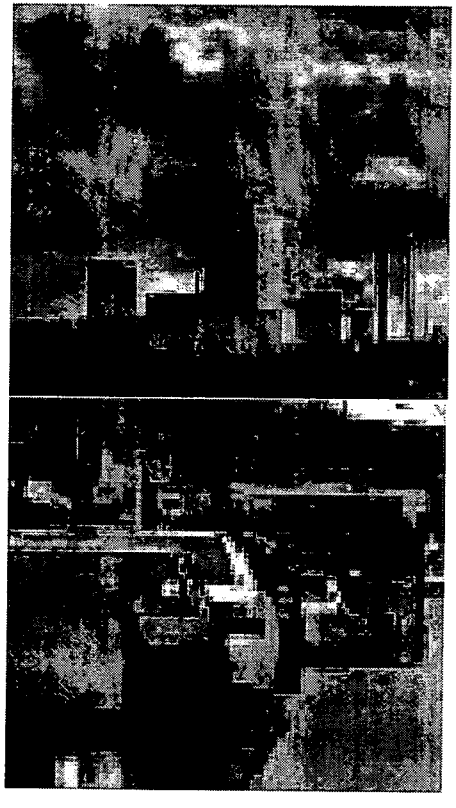
Causes of change

Changes in carbon dioxide concentrations

The atmospheric concentration of carbon dioxide in 2005 exceeds by far the natural range over the last 650,000 years



Causes of change



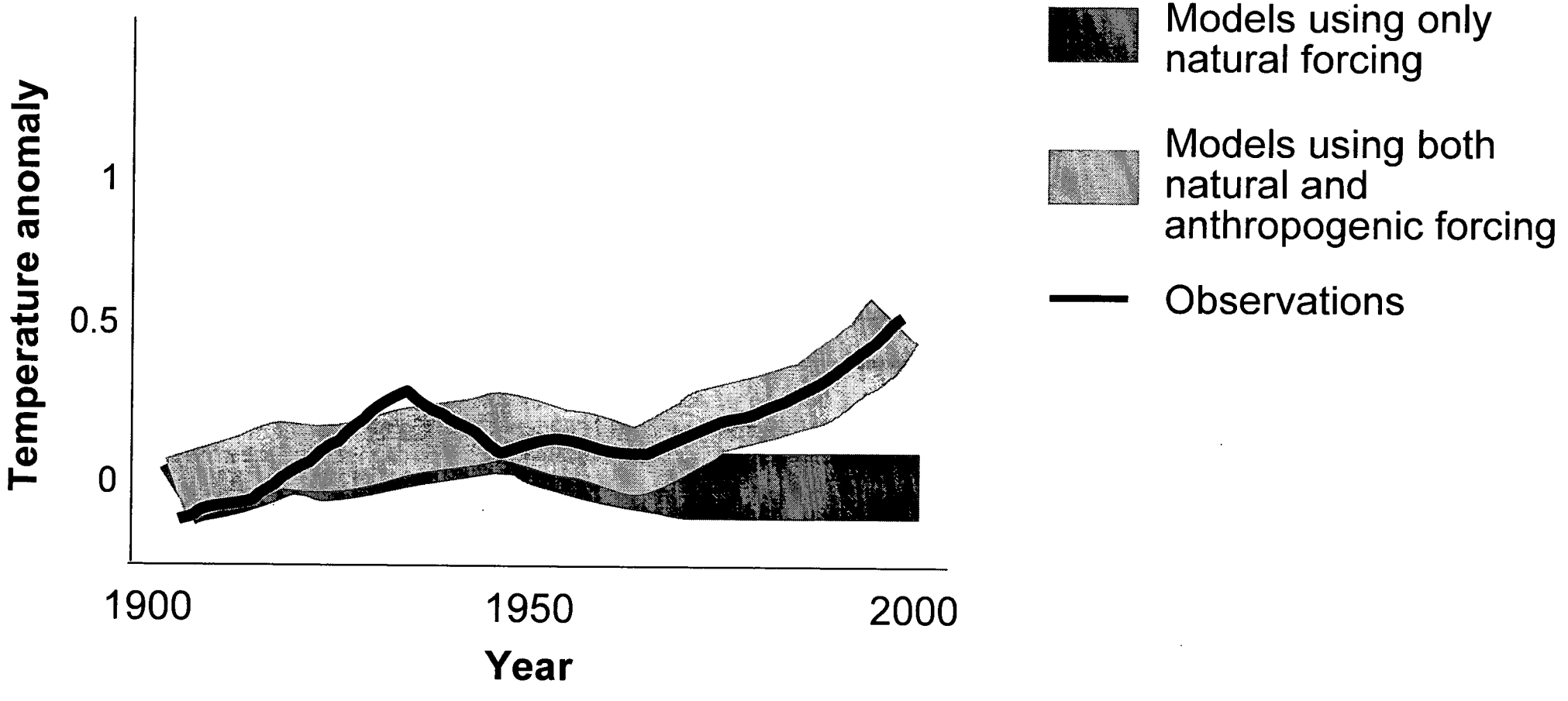
Global **GHG emissions** due to human activities have grown since pre-industrial times, with an increase of **70%** between 1970 and 2004

CO_2 annual emissions grew by about **80%** between 1970 and 2004

Most of the observed increase in temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic GHG concentrations

Causes of change

Global temperature change



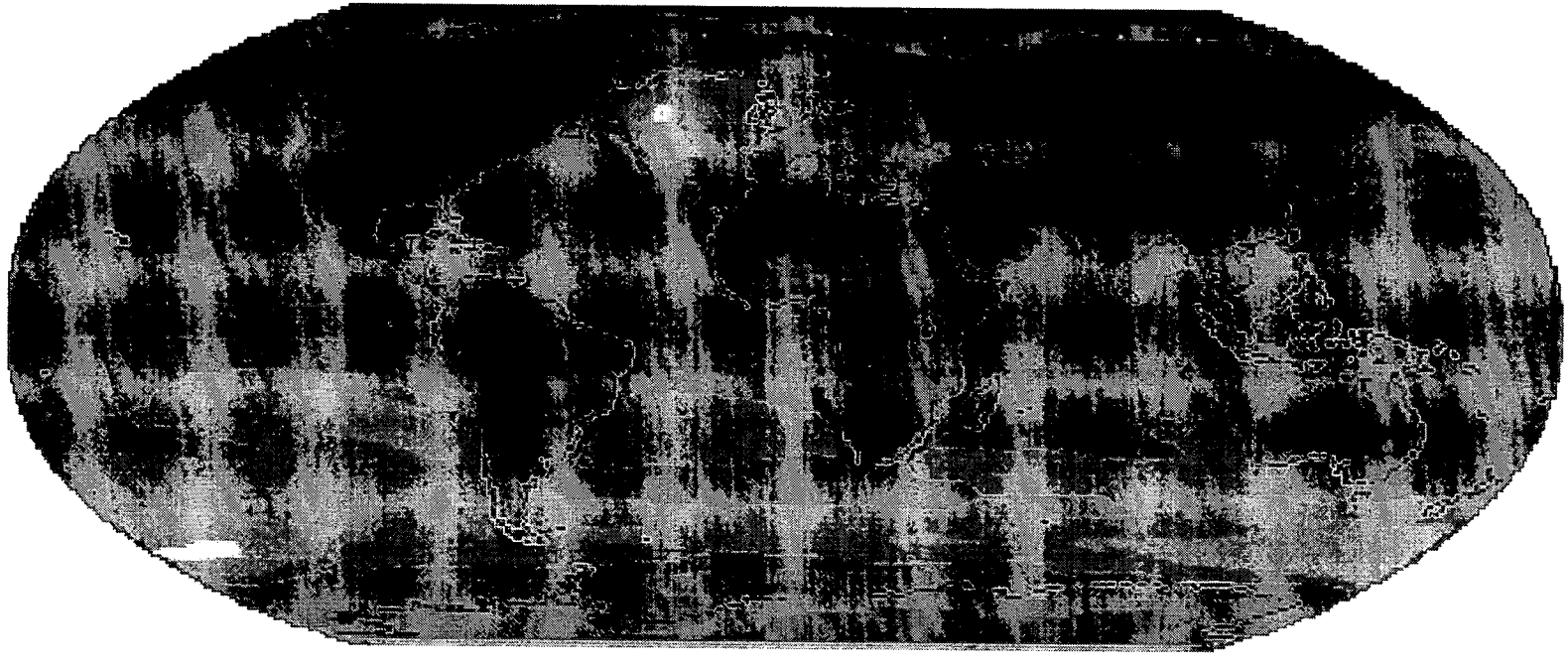
Observed patterns of warming are simulated only by models that include anthropogenic forcings

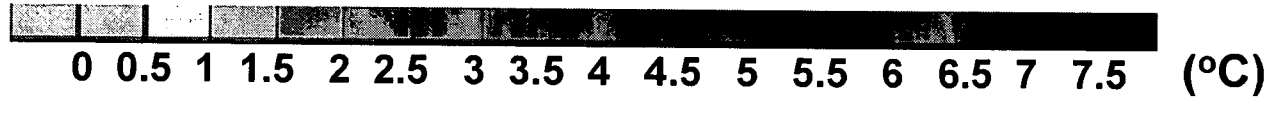
Continued GHG emissions
at or above current rates would cause
further warming and induce
many changes in the global climate
system during the 21st century that
would very likely be **larger than those**
observed during the 20th century

Projections and impacts

Projected surface temperature changes

(2090-2099 relative to 1980-1999)

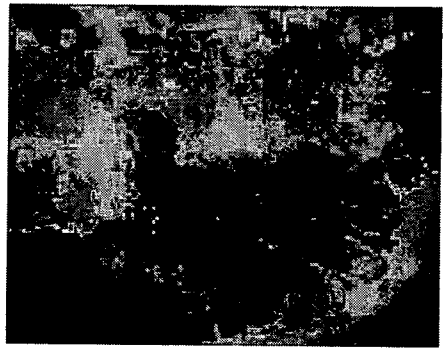




Continued emissions would lead to further warming of 1.8°C to 4°C over the 21st century

Projections and impacts

Abrupt or irreversible impacts



Partial loss of ice sheets on polar land could imply several metres of sea level rise

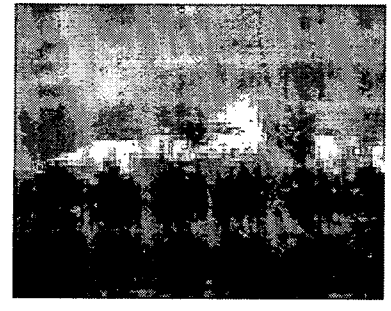


20-30% of species are likely to be at risk of extinction if increases in warming exceed 1.5-2.5°C

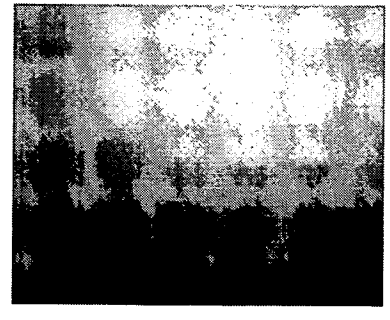
Projections and impacts

Impacts on North America

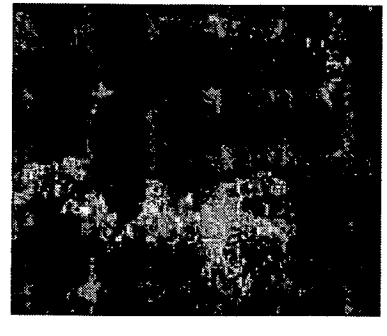
Warming in western **mountains** is projected to cause decreased snowpack and reduced summer flows, exacerbating competition for over-allocated water resources



Increased number, intensity and duration of **heatwaves** will have potential for adverse health impacts



Coastal communities and habitats will be increasingly stressed by climate change impacts interacting with development and pollution



Key vulnerabilities

Vulnerable populations

The poor have **limited adaptive capacities** and are more dependent on **climate-sensitive resources**

Vulnerability in **Africa, Asia and Latin America** is aggravated by other multiple stresses

Within other areas, **the poor, marginalised communities and the elderly** are particularly at risk



Key vulnerabilities

Security

The threats to stability and human security inherent in the impacts of climate change have been acknowledged by the Norwegian **Nobel** Committee in 2007

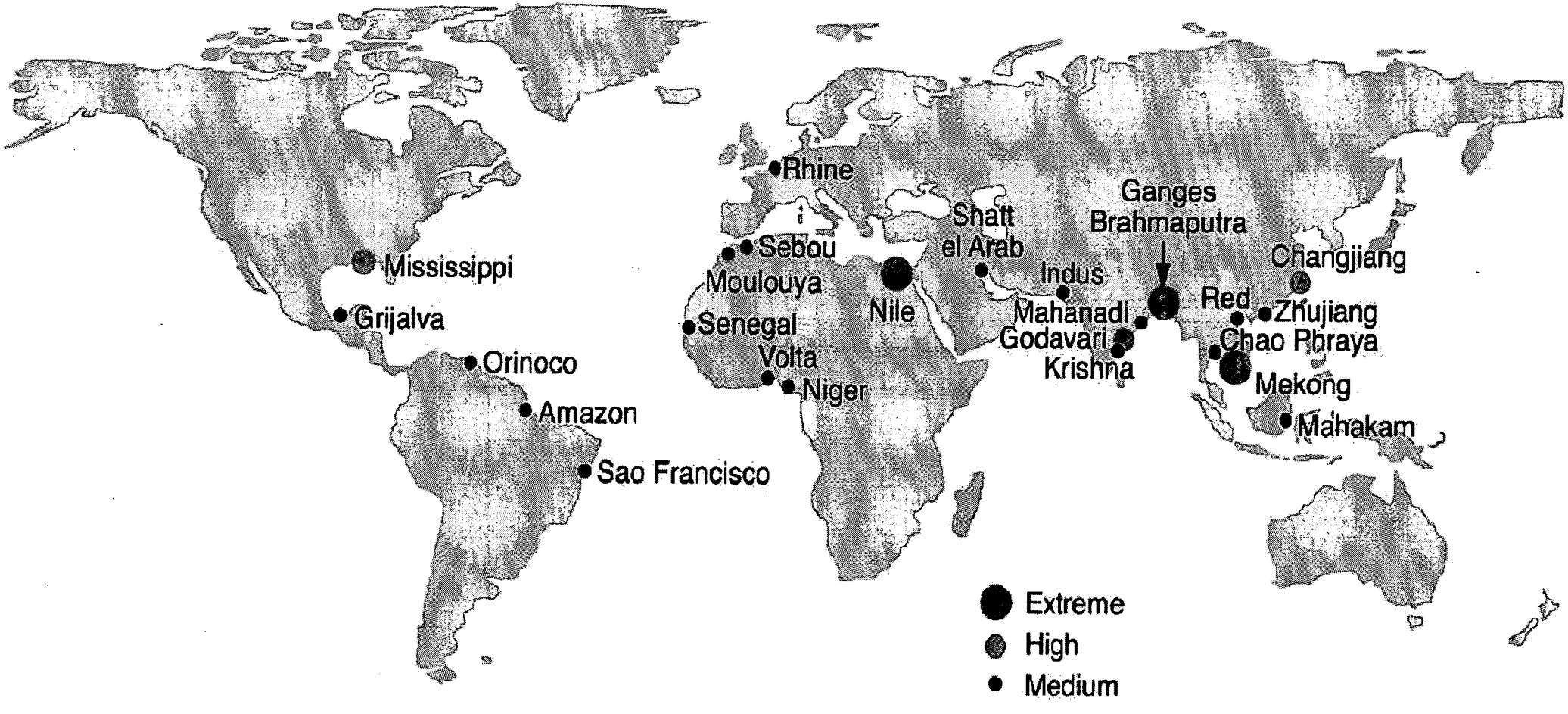


Climate change could adversely impact **basic needs**:



- Access to food
- Access to water
- Stable health conditions

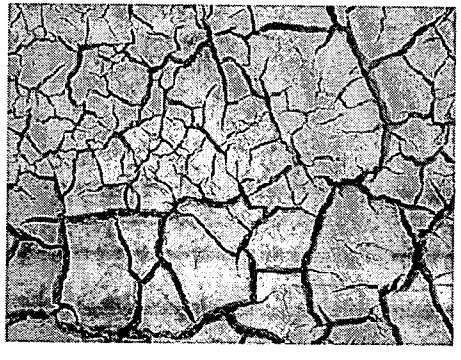
Key vulnerabilities
Coastal deltas



Coastal populations are expected to increase rapidly, while coastal settlements are at increased risk of sea-level rise

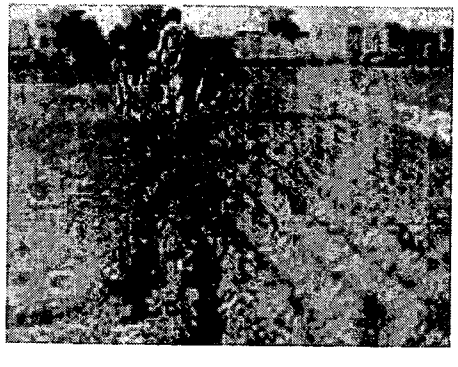
Key vulnerabilities
Food supply

Agricultural productivity at low latitudes likely to suffer severe losses because of:



- high temperature
- drought
- flood conditions
- soil degradation

Possible yield reduction of:

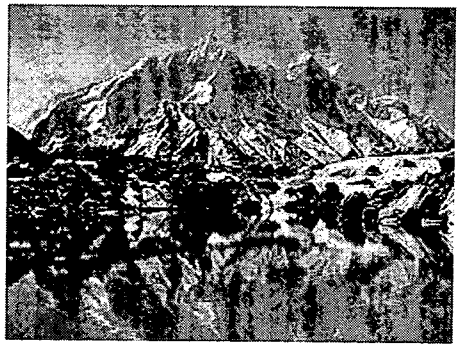


- 50% by 2020 in some African countries
- 30% by 2050 in Central and South Asia
- 30% by 2080 in Latin America

Crop revenues could fall by 90% by 2100 in Africa

Key vulnerabilities
Water availability

Water availability will be affected for consumption, agriculture and energy generation due to:



- Changes in precipitation patterns
- Increasing salinity of groundwater
- Glaciers melting decreasing river flows

Ranges of people exposed to increased water stress:



- 120 million to 1.2 billion in Asia by 2020
- 75 to 250 million in Africa by 2020
- 16 to 44 million in Europe by 2070

Key vulnerabilities

Human health

Increased **deaths, disease and injury** due to heat waves, floods, storms, fires and droughts

Increased frequency of **cardio-respiratory diseases**

Increases in **malnutrition** and consequent disorders

Increased burden of **diarrhoeal disease**

Exacerbation of abundance and/or toxicity of **cholera**

Key vulnerabilities

Need for study of impacts specific to North Carolina

- Coastal settlements
- Mountain ecology
- Human health
- Agriculture
- Water resources

Mitigation targets

Climate system inertia: even if GHG concentrations were held constant, further warming trend would occur in the next two decades at a rate of about 0.1°C per decade

Energy system inertia: delayed emission reductions lead to investments that lock in more emission intensive infrastructure and development pathways

Choices about the scale and timing of GHG mitigation involve balancing costs of emission reductions against risks of delay

Mitigation targets
Stabilisation scenarios

Stabilization level (ppm CO_2-eq)	Global mean temp. increase (°C)	Year CO_2 needs to peak	Global sea level rise above pre-industrial from thermal expansion (m)
445 – 490	2.0 – 2.4	2000 – 2015	0.4 – 1.4
490 – 535	2.4 – 2.8	2000 – 2020	0.5 – 1.7
535 – 590	2.8 – 3.2	2010 – 2030	0.6 – 1.9
590 – 710	3.2 – 4.0	2020 – 2060	0.6 – 2.4

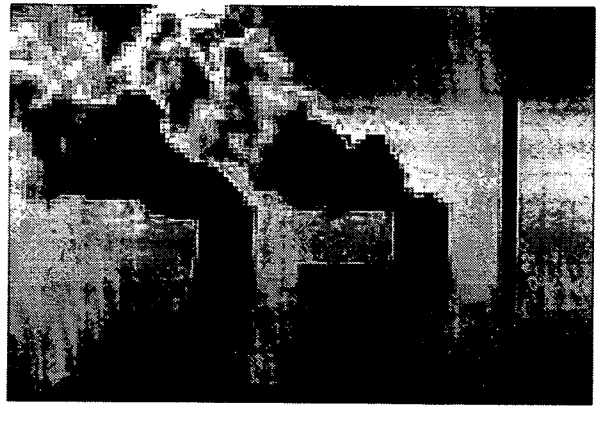
Mitigation efforts over the next two to three decades will have a large impact on opportunities to achieve lower stabilisation levels

Mitigation targets

Beyond the Kyoto Protocol

The emission target to limit warming to a 2.0 to 2.4°C increase would require **developed countries** to significantly reduce their emissions below 1990 levels:

- 10-40% by 2020
- 40-95% by 2050



Developing country emissions need to deviate below their projected baseline within the next few decades

Potential and cost of mitigation

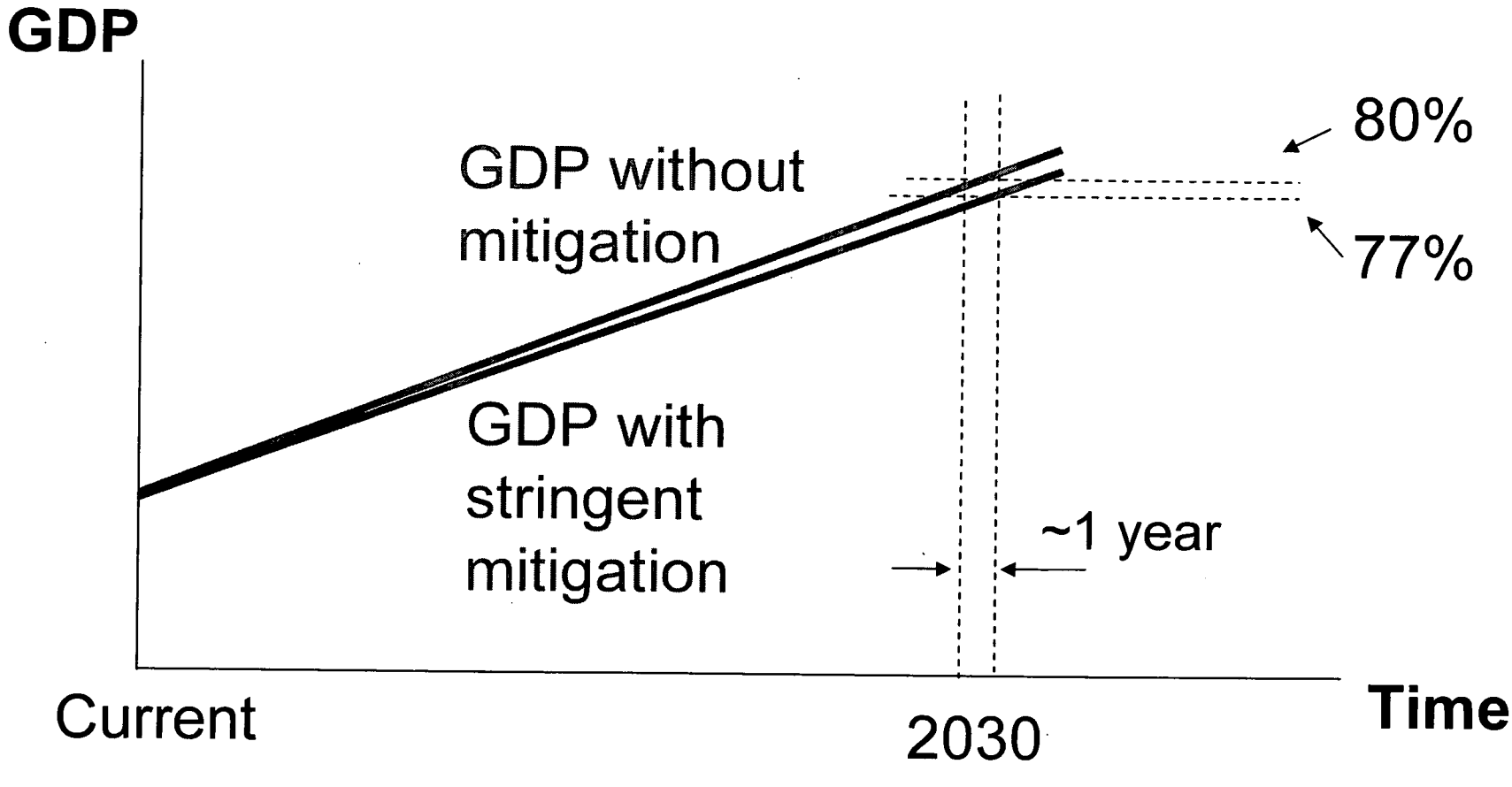
Costs of mitigation in 2030

Stabilisation levels (ppm CO2-eq)	Range of GDP reduction (%)	Reduction of average annual GDP growth rates (percentage pts)
590 - 710	-0.6 – 1.2	< 0.06
535 - 590	0.2 – 2.5	< 0.1
445 - 535	< 3	< 0.12

Mitigation measures would induce 0.6% gain to 3% decrease of GDP in 2030

Potential and cost of mitigation

Impacts of mitigation on GDP growth



Stringent mitigation would postpone GDP growth of one year at most over the medium term

Potential and cost of mitigation

Co-benefits of mitigation

Health co-benefits from reduced air pollution

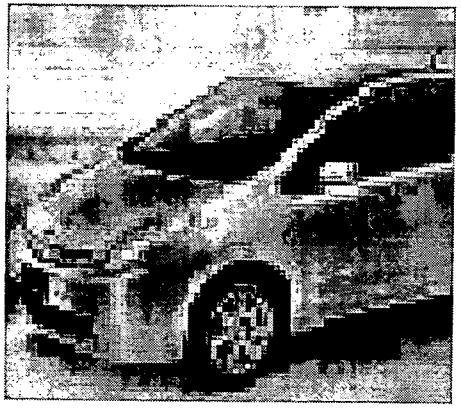
Increased **energy security**

More rural **employment**

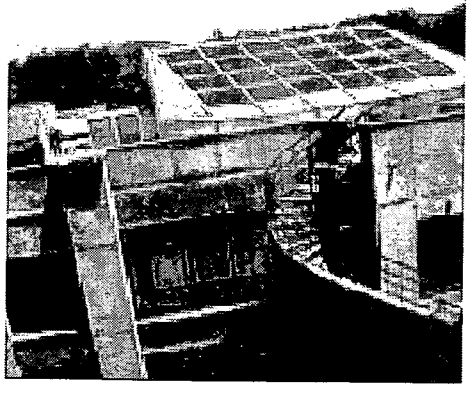
Increased **agricultural production** and reduced pressure on **natural ecosystems**, due to decreased tropospheric ozone concentrations

The co-benefits of mitigation may offset a substantial fraction of mitigation costs

Mitigation options



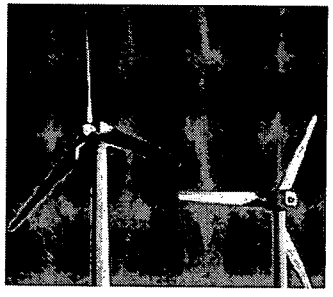
All stabilisation levels assessed can be achieved by deployment of a portfolio of **technologies that are currently available or expected to be commercialised** in coming decades



This assumes that **investment flows, technology transfer and incentives** are in place for technology development

Mitigation options

Key mitigation policies and practices



Appropriate energy infrastructure investments



Research, development and demonstration



Changes in lifestyle & management practices

Effective carbon price signal

Mitigation options

Companies that take the lead would meet with success in both business and societal contexts

- ✘ Those that lag behind would suffer from losses in the marketplace and loss of reputation

Nations that show commitment to the growing global consensus would gain prestige

- ✘ Those that stand unmoved would lose political power and influence

Man did not weave the web of life,
he is merely a strand in it.

Whatever he does to the web,
he does to himself.

Chief Seattle, 1854

Global Climate Change Commission
March 5, 2008
643 Legislative Office Building
Minutes

Mr. Garrou called meeting to order at 10:15 a.m. and welcomed Ms. Sonya McKay and the 7th graders from Exploris Middle School here in Raleigh. Members present include: Mr. Garrou, co-chair, Representative Harrison, co-chair, Senator Albertson, Representative Thomas, Representative Underhill, Dr. Eggers, Mr. Tim Toben, Mr. Thomas Cecich, Ms. Susan Tompkins, Mr. George Everett, Mr. Preston Howard, Mr. Michael Nelson, Mr. Mitchell Peele, Mr. Daniel Phaneuf, Dr. Ryan Boyles, Dr. Stanley Riggs, Ms. Jane Preyer, Mr. Robert Slocum, Dr. Stephen Smith, Mr. James Stephenson, Dr. Godfrey Uzochukwu, and Dr. Pete Andrews. The visitor registration is attached as **Exhibit A**. The agenda is attached as **Exhibit B**. Mr. Garrou called on George Givens for remarks.

Mr. Givens: Noted that we have three basic items, a discussion of the Climate Action Plan Advisory Group or CAPAG recommendations and what we are calling a consolidated format. You may recall a couple of meetings ago we went through one of those five technical areas and after we got through that we thought it would be better to shrink wrap that presentation. So that is the effort today. At some point I suspect that there will be some desire on the part of some members of this commission to adopt some or all of those as recommendations or at least as matters to be considered for further work by this commission in terms of developing proposed legislation. That doesn't have to happen today. We have not yet received the final CAPAG report the Division of Air Quality is working on that we expect to hear from Mr. Peterson and that will be the main item of the meeting. He was flying in this morning and I expect him momentarily – we intend to start in just a moment with Bill Holman who is going to present on options from state and local governments to consider in regards to adaptation. We are beginning to look at adaptation as an issue and then we had a request from Mack Pearsall with the Center for Environmental and Climatic Interactions in Asheville for some time on the agenda to explain what they are doing up there. We expect today to finish by 1:00 at the latest – we have not scheduled a lunch break.

I call your attention to the two additional meetings that are scheduled and in particular to the April meeting which was rescheduled in light of other scheduling considerations. The co-chairs and counsel met recently for an extended period of time and have developed the following plan for the balance of this interim. As to the future of this commission, as the law now stands this commission is expected to file a final report to the 08 session and then terminate. In talking with various folks it appears that we are not going to get out of the problems we are in with regard to global climate change in the space of two to three years and so there is a perceived need for some continuing entity to deal with both the mitigation topic and the adaptation topic. The current thinking on that is to extend the life of this commission by one more year until the 2009 session at which time it probably would be appropriate to consider some restructuring and I'll be happy to entertain your ideas and thoughts about that. There are various considerations that are under review as to how a restructured commission might be constituted. I will tell you that one of the important considerations is that we do not want to lose the expertise that has been developed and demonstrated among all of those of you who are non-legislators. That matter is under review.

With regard as to how we are going to proceed, today as I indicated we are going to have those discussions of the CAPAG recommendations and some discussion of adaptation. We will continue to work on both of those topics and we expect to have the final report including a microanalysis by Appalachian State University. There is discussion underway as to whether the final CAPAG recommendations and their economic analyses should be developed as two documents or one and presented as one item or as two items – that is a CAPAG matter that is under consideration. We expect at the April meeting to begin to discuss whether the state should set a greenhouse gas emissions reduction goal and if so what that goal should be. The general thinking about the way those goals are expressed is to achieve with reductions and emissions so as to produce emissions for some historic level. The normal base year often discussed is 1990 and to achieve those reductions by some schedule that might be spread out to 2050 and those are not suggestions they are just a description. Behind that idea is the idea of holding the parts per million of greenhouse gases in the atmosphere to some number less than 500 on the order of 450. You can be thinking about that and we'll have some material for you and some discussion of that in April.

With regard to the specific area which is mobile source emissions we have had some requests by the Automobile Industry to present on that topic and also some possible discussion of clean cars legislation. That is the adoption of the California Motor Vehicle Standards for North Carolina. A number of states have done that – where that matter stands at the moment is that the USEPA has declined to grant California a waiver that is required under the Clean Air Act for those standards. That matter is now in litigation and is likely to be resolved early next year since most observers believe that the next administration is likely to take a different view of the current administration on that waiver.

Commissioner Choi has asked us to hear a presentation by Effery Electric Power Research Institute and we expect to do that as well. We hope by the April meeting to begin transitioning into May and to actually have an interim report.

Mr. Garrou: Any questions of Mr. Givens? If not we will begin the agenda out of order by asking Bill Holman who is the Visiting Senior Fellow, Duke University Nicholas Institute to give us his presentation.

Mr. Holman: Good morning – I appreciate the opportunity to appear before you and I'm going to spare you a power point this time. A handout is coming around (**Exhibit C**) and I want to try to be responsive to the Commission and bring you some options to consider, these are not recommendations, and I bring them in the spirit of starting a debate in our state about how we should approach a very complicated and challenging problem of adapting to our global climate change. Just a really broad overview – one of the things that is challenging about this issue is there is really no one in our state who is responsible for taking the lead in our state for preparing for planning for adapting to climate change. We don't have any goals, we don't have a plan. We have a lot of programs going on but there is not an overall goal or plan and that's the spirit of my options before your begin to throw out some ideas that might become a plan. Just in the way of background as Mr. Givens already said there are efforts underway. You know the countries and our country is trying to stabilize and reduce emissions of greenhouse gases. Despite those efforts we're still looking at the problem that will increase in greenhouse or in concentrations of carbon dioxide in the atmosphere of about 450 parts per million by 2050. So there is an urgent need for strategies that you've been debating for many months to reduce the emissions of greenhouse

gases but because of emissions that you've already occurred and will occur in the future - there is going to be some warming of the climate. It is now an appropriate time to begin these discussions. We've thought of this adaptation issue as something of the future but I would argue in fact that we are adapting now in a hap hazard way but we are adapting now to global climate change. Our citizens are investing in beach nourishment projects we're building a dike around Swan Quarter, we're paying higher property insurance, we're hardening the estuarine shoreline. There are a number of activities that are underway that are part of the adaptation to sea level rise and climate change that really is no overall plan but those hap hazard actions are occurring. We don't really have good North Carolina data to make predictions about climate. We've got these regional climate (inaudible) national and international climate models are pretty good about predicting the international picture but in terms of how the weather in climate is changing in North Carolina, NC State's ECONet program they've got 30 monitoring stations around our state. We also have 100 counties we have different elevations even within counties so we don't even have very good information about the specific changes in climate in different parts of our state. Some of the general theory about climate change is that the warmer air will hold more moisture and that should produce more rain which we obviously are not seeing this year but maybe that is the long term trend. But that rain may be delivered and more intense storms so that may cause us some challenges with more runoff, less groundwater infiltration and all the models we use for water supply for the design of our waste water systems for the design of our storm water structures for our flood plains – they are all based on historical weather data. There is a recent article in Science Magazine called Stationarity which that is a new word for me. Stationarity is dead with our water management is really talking about the challenges that water managers will have in the future because all of their calculations about how much water is in a reservoir and planning for the future is based on historical weather data. Since the climate is changing it may make it more difficult to protect precipitation, to protect lake levels and that's just a challenge that we're going to face.

Obviously how the weather also increases evaporation for water supplies stresses crops and landscaping and decreases the ability of warmer water in the summer to cool our nuclear and coal fired power plants and hotter summers can lead to unhealthful levels of ozone. Sea level rise is a big challenge for us as Dr. Riggs knows a lot more about this than I do, but we've got about 1.2 million acres in North Carolina that are below one meter or below about three feet in elevation and particularly vulnerable to sea level rise and storm surges. There is a recent study by scientists at East Carolina, Appalachian State, UNC-Wilmington and Duke that estimated that about 6.9 billion dollars worth of property in just four coastal counties is at risk from sea level rise. I know you've been debating about the cost of reducing greenhouse gas emissions, there are real cost associated with the impacts of global climate change. Here are some options to kind of kick off the debate – the basic one is just inventory and understanding the existing programs that were maybe not intended to adapt to global climate change but in fact have some bearing on that. So we have the Homeland Security, Federal Emergency Management programs, the Army Corps of Engineers involved in hardening projects and in beach nourishment projects, the Department of Agriculture does deal with disaster, there are programs in the Environmental Protection Agency, DENR, Crime Control Public Safety, we have a lot of existing agencies that are active in this field. Then there is no coordinated effort but I think it would be helpful to you if the next administration have a better sense for who is acting in this area and where the conflicts are between policies and programs so that we just have a better understanding of what's in play. There may be some barriers in programs or some things where the programs really need to be made more flexible – a program needs to adapt so that it can play a role in adaptation, so inventorying existing programs. I would

say we need to be thinking about developing and adopting some goals and principles for adaptation. Again our current situation is we got a lot of different programs they are not really set up with adaptation in mind but they are acting in this area and that will continue to happen until the governor and General Assembly sets some clear goals and principles about this. This is the direction North Carolina needs to take in adaptation these are the things that are important to us as a state and that will help guide other public and private decision makers. There are some other good tools – our Customary Management Act the Federal Coastal Zone Management Act have this thing called consistency in them as a way of better knitting together state and local and state and federal coastal management policies. Our state Environmental Policy Act can be amended to require our consideration of both emissions of greenhouse gases and as we're building new infrastructure, whether it's a wastewater treatment plant or sewer line or new bridge or highway, if sea level rise or climate change is going to impact that infrastructure, that needs to be taken into account because you build wastewater plants for 50 years. So again looking at some sort of clear goals and principles from the state I think is an (inaudible).

Improving climate data and research – we don't really have the information we need to predict the impacts of climate change, the droughts, the floods or the weather and then NC State has a great ECONet system but again it only has 30 monitoring stations in our state and cost about half a million dollars a year to make that statewide and maintain that. I think that will be valuable not only to folks working on adaptation but folks who care about drought and people who are working on water management. Lots of people depend on basic weather information and having more localized data would be beneficial and obviously you have an expert here in Dr. Boyles who can provide more information about the value of that monitoring network. We already have in North Carolina some great resources for climate research – there is the National Oceanic & Atmospheric Administration has the National Climatic Data Center in Asheville. Asheville is developing a Center for Environmental & Climatic Interaction that I think Mack Pearsall will tell you about later. UNC Chapel Hill is one of the leaders in the country in atmospheric modeling, Duke University has great expertise in the climate/energy policy and the emerging carbon markets and there is expertise on other campuses too. So I think there is an opportunity here for some more just basic research and data collection and sharing that with public and private decision makers. You can think about perhaps setting up a consortium modeled on the Water Resources Research Institute which is a public/private university consortium that funds water research in our state and has been very valuable.

We need to plan for droughts and extreme weather – we've always had droughts, we've always had floods but again the scientists are predicting we may have more severe or extreme storms in the future and there are some efforts already under way but I think it would be beneficial for the state to really direct the Department of Environment and Natural Resources and the State Water Infrastructure Commission to really work actively with the League of Municipalities, the American Water Works Association, the engineering community and others to provide the kind of technical and financial assistance that both public and private water, wastewater and stormwater systems are going to need. Again we are looking at hotter temperatures, droughts, intense storms and we need to make our water, wastewater and stormwater systems more drought and flood resilient. One of the things we've discovered in the drought is different communities use a different definition for safe yield – that is their way of predicting how much water they have and it really varies whether it is Raleigh or Durham or Charlotte or Asheville. The different calculations/different risk factors taken into account – safe yield is a very fundamental concept in the water business it may be

useful to have a consistent definition across the state so that when the governor is asking a city how many days of water they have left he or she has a good sense for making the same assumptions about that and again amending the Water Supply Planning Act and the North Carolina Drinking Water Act to provide a standard definition I think would yield to better planning. Also getting our Environmental Health agencies to know when they are reviewing water plans that is a good time to be asking how are you going to guarantee/how are you going to provide those water resources in the future, have you thought about the next severe drought and the same for the Utilities Commission.

Our Department of Crime, Control and Public Safety already has a good program called Storm Ready. It is a set of best practices that they worked with primary municipalities and counties on and that could be adapted into more of a climate ready. Again the same thing is we find a lot of mayors and commissioners are concerned about this issue but we are not really clear what we should be doing. The Department of Crime, Control if you use that existing program to build upon it you get people thinking about what they need to be ready for the future.

Planning for sea level rise and more intense storms – we already have a good fundamental planning tool in the North Carolina Coastal Area Management Act and it could be beefed up to require that sea level rise be considered in things like permit decisions and in local land use plans. We could increase protection of coastal wetlands and their ability to migrate inland. One of the great things about coastal wetlands is they are not only productive for our finfish and shellfish and they filter water pollution but there is actually some ability for them to grow as the sea level rises and they also provide protection for inland properties. We are loosing a lot of our coastal marshes because we are hardening the estuarine shoreline. We're building bulkheads and when the wetland hits the bulkhead there is no place for it to go so it just erodes away. This is a very challenging issue of the coast it has been debated for over a decade but I think it is time we really have additional public and thoughtful debate about this. We have some tools in the Coastal Area Management Act, the area of environmental concern where you can come up with some coastal wetland where perhaps the most significant wetlands can be protected. Obviously we will probably keep the seawall or the bulkhead at Beaufort and Morehead City and some of our coastal communities. So we have to make bouncing here but we do have some very important coastal wetlands and we have some tools to deal with it and it is just time to get on with looking at those tools. And the same for the ocean front – North Carolina has a model law to protect our ocean beaches, our model law recognizes that sea level is rising and that the barrier islands are moving and I think that has served us well in adapting to the sea level rise. We have an Albemarle/Pamlico Natural Estuarine Program and they borrow some information from EPA. EPA has something called a Climate Ready Estuaries Program again, those are some things that the states should consider for rising sea levels.

Maps and public information – if you wanted a map of sea level rise it is really hard to get if you were considered buying a piece of property. That is the kind of information we ought to make available to the public so they can be informed and make wise choices about development and land use decisions. There is an easy way to do that through our NC One Map program. We have a number of programs that are already kind of active in this area but they are not well coordinated and you can think about certainly improving coordination as a first step. You can debate whether it would be wise to consolidate our natural hazard planning and regulatory programs. Those programs are principally in DENR and Department of Crime Control and Public Safety but we

ought to take a look at how effective those programs are at either their technical assistance, educational program, their financial assistance, mapping, how well are those programs working and could they be better coordinated or would it be more efficient to do some consolidation. For example our flood plain management and stormwater management programs are in two different departments, they're complimentary and they certainly could be more effective if they were coordinated in the future.

Finally another idea is to put out for public debate is should we establish a North Carolina Hazard Mitigation Fund so that we can acquire conservation easements or fee simple properties that are in the flood plain or they are in high risk areas so we can protect the public, prevent property damage and lower risks before sea level rises and storms occur. That obviously would cost money and funding options would be appropriations from the General Fund or you could consider something like a fee on filling and floodplain or building in high risk areas or even a surcharge on property insurance. All of those are controversial I understand but there are some areas in the state that we know will be very vulnerable to sea level rise and storms and if we will want to move people out of harms way we will need to have some way to finance those efforts. With that Mr. Chairman I will be happy to answer any questions and if there are any of these recommendations the Commission is interested in carrying forward in the short session we would be pleased to work with your staff in drafting a proposal and I also think there are other good ideas out there on this issue and again this is in the spirit of let's start a debate about adaptation and let the good ideas come forward. Thank you.

Mr. Garrou: Thank you Mr. Holman. Questions?

Dr. Riggs: Thank you Bill that was very good summary and statement. I want to make a comment first and then ask a question. We have many different aspects of the state government that are moving forward with very critical issues right now as we speak. To continue business as usual out there in the coast and this underscores the absolute criticalness of the time of timing with respect to going ahead because these issues will block the barrier island coastal system up. Not just for the next 10, 20, 50 years but forever, the way we do business out there and for example the Oregon Inlet bridge by itself is not a problem but connecting it to Pea Island which is a collapsing island and going away and the total cost of 1.5 – 2 billion dollars before we're done to build a bridge road system to nowhere 25 years from now is not solving our problem nor looking down the road. We have in the next legislative session that will be one of the first items to come on the House of Representatives is a bill to start hardening and stabilizing the inlets in North Carolina. That's a very serious event and we can't sit by and let these processes continue with what we know on what is happening on the barrier islands. My question to you because we have so many different agencies involved and just helter-skelter sort of approach, is there any way we can put a moratorium on things like the bill that is before the Legislature in an effort to let this new sub-commission or whatever it is that Mr. Givens was talking about to get their feet on the ground and get moving with respect to how we want this coastal system to look 25/50 years from now. The military is already doing this – they're putting significant amounts of money to answer the question when sea level rise is one meter and two meter what do we have to do to maintain these bases forever and keep them operational. The state of North Carolina has to do that also and do it now.

Mr. Holman: On the question of a moratorium – is the General Assembly can act however it desires but I think to your basic point is unless there is an overall frame work plan or goal about

how the state is going to adapt to global climate change we are just going to continue to make lots of piece mill decisions and they will be going in different directions. Some will be going in an adaptation direction and some will be going in a different direction and lots of public money at stake and private money at stake too. I think it would be to the benefit of the state to have an overall goal and plan for how we are going to deal with this. There will be some difficult trade offs – this is one of the most challenging issues I've ever started scratching the surface of.

Dr. Riggs: If I could just follow up then with the Chair and Mr. Givens, can this group make a recommendation to the Legislature as to how they should hold off on that particular bill until we get our heads around some of these ideas of hardening the shoreline. That's a pretty serious step right now that North Carolina is about to take.

Mr. Garrou: Absolutely we can do that – we will be making an interim report or we will be considering this among ourselves making an interim report to the Legislature for this short session and that can be one of the aspects absolutely.

Dr. Eggers: I just want to back up what Stan Riggs just said about hard stabilization and also beach Renourishment projects generally being such unwise use of taxpayer money to put it kindly and often is the case and probably a moratorium would be good. Sediment transport and all the long shore processes are complicated and it is hard for people to understand these but we should not run to stabilize our shores – that is not very feasible. Bill thank you for that presentation that was very good. When I think about what is going on at the coast and kind of business as usual approach and how fast houses are going up and I think all these should be at this point designed for this assembly or at least not maybe technically all the way designed for this assembly but designed in such a way that they can be taken apart and put on a truck and pulled back. That's what economically would be wiser – is there any place in here that would address US standards in terms of the recommendations from (inaudible)?

Mr. Holman: In the coastal area the Customary Management Act with the state and local partnership and actually when the Coastal Resources Commission adopted a rule in late 84 or early 85 banning sea walls at that time there was a little more room on the barrier islands. So there was a lot of moving structures back and because we've built out there, there are still some places where that are options but it is getting more challenging to retreat. Sea level is not just rising on the ocean front it is also raising on estuarine shoreline. Dr. Riggs knows more about the space available or the move of the barrier islands and that sort of thing. Those are difficult questions but if for example, you can generate maps that show if the sea level goes up a foot, here is what goes under water or here is what is more vulnerable to a storm surge and so you can identify more risky areas where property is going to be at risk and then you can begin to have that discussion on how do we respond to that. Do we have building retreat strategies or for some of our coastal towns, do we raise the seawall or something like that, not the seawall but bulkhead or that sort of thing. I think we need to begin the discussions about identifying those areas that are most at risk and then figuring out how we are going to respond. We will have to respond sooner or later and we would be better off responding with a thoughtful plan rather than reacting in a crisis like New Orleans is trying to do now.

Dr. Eggers: Your answer to this might be the same and if it is just say it is the same. It seems like one of the highest leverage approaches to really get the attention of public officials on the coast

with regard to the need to do something in the very real impacts that this will have and even in near term would be to have based on inundation maps of eight inches a foot for them to have to make plans for what they will do in response to the loss of local tax revenues and other revenues and how they will handle that. Is there any recommendation here that would tie directly into that?

Mr. Holman: No but this is a list of options and you can add and subtract as the Commission (inaudible). But those are good issues that you raised.

Ms. Tompkins: Could some of this be addressed through North Carolina real estate law some of these problems of construction and deconstruction and titles and sellers and buyers conveying the right maps and surveys and so forth. In other words North Carolina real estate law can be dovetailed with some of the new mappings.

Mr. Holman: Yes and the General Assembly could decide to require that kind of information to be disclosed or again making the maps more widely publicly available so that again people are making important decisions and taking that risk into account. And that is not just through the coastal area we've got flood plains all across North Carolina and if we have more intense storms we may see more localized flooding as well.

Ms. Tompkins: And also the insurance industry could be involved in that. I think they need to dovetail with the maps.

Mr. Holman: Yes I agree and I think it would be wise to at some point engage the insurance industry to learn more about how they're taking these risks into account and again I hope they'll be a real benefit to a hazard mitigation fund and rules and regulations and those sorts of things so that our history is every time we have a large storm everybody's property insurance goes up. We can do things to minimize risk perhaps we can also minimize those premium increases in the future.

Dr. Andrews: Bill thank you for a very valuable start on an important topic here. I am struck by a couple of things – one is the need for measures that are both proactive and reactive. That is a number of these are directed toward improving our capacity to respond to the particular events that are likely to become more frequent; but others are really touching a much deeper challenge which is how do we plan for a world, a future economy and a future state in which more of these sorts of things are likely to happen. And so I am wondering if you can say a little bit more about how we develop the institutional capacity to do that because you've touched on several key sectors here – the coast everything that goes with the coast to begin with. But I'm wondering whether there may not be deeper issues also in agricultural planning, in utilities planning because the trade offs that I believe Duke Energy for example is already facing between the use of reservoirs for power purposes and to save and drinking water. There are a number of cross sector interactions and I was wondering if you could say a little more than just the state and Environmental Policy Act with all its promised but all its limitations about how we might tackle those sorts of questions.

Mr. Holman: That's a great question – I can envision a role for the Department of Commerce and the university system and outreach to the business community and planning. There are some sectors that will be a lot more effective by climate change than others but we are making sure our folks are aware of the kinds of changes that scientists are forecasting. Certainly that is true in the agricultural area where we may need to work with our Department of Agriculture, NC State, A&T

State. We may see some crop shifts or may need to do some more research on drought tolerant plants and that sort of thing. This is one of the most challenging issues I've began to scratch the surface of so I am sure there are far more implications here than I am prepared to address and I hope others will speak up about their concerns and the kinds of things whether it's a program or outreach that the state needs to put in place so we can get ready for this change in our climate.

Mr. Garrou: Thank you Mr. Holman for your presentation.

Mr. Stephenson: I wanted to mention that the Climate Action Plan Advisory Group also looked at this topic and came up with one of the subgroups of that, that looked at cross-cutting issues in its report, and this is something that is not shrink wrapped which is why I wanted to bring it to the full Commission's attention. There were two preliminary recommendations that were made by the cross-cutting issues technical work group and a whole host of possible responses to any number of topics relative to adaptation including tropical storms, sea level rise, agricultural, forestry, fisheries, etc. The two preliminary recommendations I wanted to mention – one was to suggest that the General Assembly enact legislation to require sellers of coastal properties to disclose potential hazards to buyers, the coastal hazards disclosure should accompany all real estate transfers of property with ocean fronts, sounds or creek frontage in coastal counties. That is one that wasn't part of the presentation that Bill just gave us but I think it is one that's popped out during our interim report last year and the second is one that Bill did include, this last recommendation Bill referred to it as North Carolina Hazard Mitigation Fund. The recommendation of that cross-cutting issue group of the CAPAG was to create a coastal adaptation program that would be funded through a surcharge on the NC Beach Plan or some insurance surcharge. The funds would be targeted for the purchase of conservation easement on low lying coastal land but also for (inaudible) incentive with land owners for construction of ecologically beneficial for erosion control structures on estuarine shorelines which gets to a second recommendation that Bill brought forward. The problem that we have in North Carolina right now is approximately 30 miles of estuarine shoreline are bulk headed every year and that is an enormous amount of habitat that is lost to fisheries in our state. The other use of the fund the CAPAG cross-cutting issue group recommended was to use it for research to provide an assessment of the physical and ecological properties of the estuarine shoreline and potential cumulative impacts. I guess the one that pops out from the Institute for Environmental Policy Solutions report that they've shared with us today that I would like to see us bring forward as a priority is the establishment of a North Carolina Hazard Mitigation or Adaptation Fund and I hope that we will look at that more closely as we proceed.

Ms. Preyor: I thought Bill did a great job of giving a look at it and it jumped out to me but there are so many pools we have actually in place that we can target on this and that was very helpful and I would also note that it was a lot of focus on the coastal aspects of this and if we think more about presenting some ideas about a plan a sort of state wide look at adaptation that might include more of the land used and water supply issues that impact the Piedmont and west of our state, I think will be important to bring out too.

Mr. Garrou: Mr. Givens has a couple of things he wants to talk about.

Mr. Givens: I failed to mention several things. First of all, we welcome as a new member of this Commission Dr. Richard N. L. Pete Andrews. Dr. Andrews comes to us ex-officio as the designated Director of the Carolina Environmental Program at UNC Chapel Hill. Douglas

Crawford-Brown designated Dr. Andrews before he stepped down. So we welcome Dr. Andrews to our Commission. He has a distinction among many distinctions of having been the adviser for Jennifer Mundt our analyst. I had contacted him and got a very favorable recommendation which has been (inaudible) out so he comes with a great deal of credibility. The second thing I will note is we are going to distribute to you at this time this document which is a prepared by the US Climate Action Partnership (**Exhibit D**). This is provided to us by a member of the Commission, Jane Preyor. Let me reiterate our policy about distribution of documents – it has been my practice to distribute all documents tendered to me with the request that they be distributed generally without comment. You are free to distribute things among yourselves but if you go through the staff, then they will become part of the record and we will make sure everybody has a copy. Lastly, I need to let you know that there is a lot of work going on across the country with regard of what the role of the state should be in climate change in the next administration. Several of us have been involved in those discussions and I thought you ought to be aware. For example, at the beginning of last week our co-chair Representative Harrison and Brock Nicholson from the Division of Air Quality and I were at the PEW Center for Climate Change meeting on federal and state regulations. I am also involved with an effort by the Rockefeller brother's fund. I took Secretary Ross's place at a meeting on that so he and I have been coordinating about that. That is another effort – Brock is also involved with one through the Air Quality Directors Association nationwide. The Air Quality Directors are in communication with the Rockefeller fund group that is basically leadership states. I am pleased to note that North Carolina is regarded as a leadership state among the countries on this issue. All of which is to say that there are a number of efforts underway to figure out what the role of the state should be and what the state should want from the next executive in the next congress in this matter. Be happy to talk further with any of you, thank you Mr. Chairman.

Mr. Garrou: Welcome Dr. Andrews to the Commission. And now we're back to the original order of the agenda and we'll ask Tom Peterson if he would give us the presentation on the CAPAG report.

Mr. Peterson: I believe there are two handouts (**Exhibit E**) available one is a table a couple of pages long and two slides per page version of the power point. It didn't reproduce the detail obviously but the full version has in it and we will be referring to that version on the screen and we will do a walk through that as we go through the table one piece at a time. I am going to walk through the power point and refer to the table as we go along so we just have one handout and the full power point on the screen. The request that I am responding to is a consolidation of the CAPAG options - there were 50 some but a long list that fell into a number of different categories and have been consolidated in a set of categories that relate to implementation initiatives and they have been aggregated and the related outcomes associated with them that we will measure as part of the CAPAG process have also been aggregated so we have a profile for each of these and we'll take a quick look at the profiles of these as well as the overall structure. We still have the full detail where all the individual options that exist in the report and some of the data that I'll show you but this is essentially a summarized version that is structured in the direction of implementation initiatives. They obviously remain flexible based on the judgments that this group would make or others in terms of how best to structure this. So what I'm going to do is walk you through what we've put together and be happy to take questions and answers along the way if that's appropriate.

The categories that we've used for organizing the actions involved six major categories and if you count them up one by one, I think we've got nine, but the first category is heat and power and this is a combination of energy demand or demand side reduction actions on one hand and then supply side actions on the other hand. The demand side actions being called energy efficiency and conservation and the supply side actions called clean and renewable energy. These again relate to what sometimes is referred to as the stationary source sector residential, industrial and commercial but it is both the generation and the use of energy as well as other processes that occur in these stationary source sectors. The second flip side of that coin often called the mobile source sector – transportation and land use. A similar breakdown originally I had one single category for the demand side actions and then split that in two pieces because it seemed evident that they were both substantial enough and different enough that they deserved that. So the first category is location efficiency which deals with land use issues, development infrastructure, etc. Things that have the potential effect of reducing or depending on how it is managed increasing travel demand. The second is vehicle operations which relates to the design and the use of vehicles whether it is café standards, clean car standards, slow rolling resistance tires, etc. A series of actions oriented towards reducing the emission of greenhouse gases from vehicles during their operation. And the last category in this set relates to the use of fuel and its carbon content and this supply category for fuels includes things like ethanol for instance but it is a supply side category that's oriented towards liquid fuels used in mobile source sector. Those are the two big categories and then following them and based on the recommendations of the CAPAG are a couple of other key categories. The first being a collection of things that relate to agriculture and forestry – they are predominantly oriented towards land protection measures, whether it's restoration and recovery or protection from lost. There is a minor action included in that relating to soil/carbon buildup which we've labeled conservation practices but they've been lumped together. Just so you know, originally in looking at this we had structured this so that there were two separate categories, one for land protection and the second for conservation practices. In North Carolina there was only one option for conservation practices. It was rather small in terms of its scaling so we simply lumped that together in one generic category here. The next category is waste recovery and recycling which relates to either direct recycling of materials or recovery of energy from waste and reuse of energy.

The next category includes a couple of different actions in the state that we've labeled state and local government. We'll walk through that in more detail, but this relates on one hand to a series of information, education, outreach initiatives that the CAPAG group had identified. On the other hand a series of what we've termed planning and capacity building measures which relate to measurement systems and inventories report and registry as well as goals and targets. The final category is adaptation which is a separate track. Bill Holman has provided a very helpful briefing on some of the key issues there and as a parenthetical note on the adaptation recommendation that CAPAG has is a separate appendix in the report that maps that out in quite a bit of detail. These are categories that were structured really as a first step towards identifying what would be dramatically, organizational, institutionally logical initiatives that could be used for actual implementation. Obviously there are a lot of different ways that you could slice and dice and lump and split the recommendations that came out of the CAPAG process. I would say that this is a fairly typical rendition although it is a little bit different as it is in every state due to the unique characteristics of the North Carolina process. Before we begin the walk through I sould ask if you have any general big picture of comments in terms of the structuring of this?

Representative Underhill: Thank you Mr. Chair. Will your power point be available to us online?

Mr. Givens: It is our normal practice to make documents available. We have a web page – we will try to post them.

Ms. Tompkins: Thank you Brock. Could you tell me what are the unique characteristics of the North Carolina process? Simply put.

Mr. Peterson: Sure. We're working in Iowa right now. Twenty-five percent of the emissions in the state of Iowa are directly attributable to agricultural practices. It is very different in North Carolina which is a much smaller number. In all likelihood in Iowa the percentage of reductions at the end of the day that will come out soil/carbon buildup practices will be very, very high. It's a low number in North Carolina. That's just one example – there are lots of differences substantially between the states – the mix of renewable, the level of efficiency opportunities that exist and those are very much reflected in the recommendations that came out of the CAPAG process.

Ms. Tompkins: What is the biggest one for North Carolina?

Mr. Peterson: The biggest in terms of?

Ms. Tompkins: Characteristic that is defining and shaping these categories.

Mr. Peterson: I would say the number one characteristic in North Carolina is in the category of being a high growth state. It is in the top tier of gross rates and emissions and that of course is reflective of growth rates in terms of the economy and population and etc. That changes the nature of both the problem and the potential solutions. It is depending on which measure you use which accounting system either 88 percent or 106 percent, but just roughly when you're knocking at the door of 100 percent growth rate through the 1990 to 2020 period that is getting into the top tier or the top third of the growth rates at stake. The low end you see a state like Pennsylvania all the way down to 13 percent.

The curves that you have in front of you on the screen is a color coded version and a label version of the supply curve that we shared with you at the last meeting. This is one that we've been able to tease out in more detail and categorize and each of the colors on this curve corresponds to one of the categories that we've seen on the slide before. This actually includes an earlier split out that we lumped back together that has the farm and forest conservation practices split out separately. It also has another category that we looked at that is not large in size but we thought might possibly be important for other reason which is state and local government lead by example actions. They are currently folded into the heat and power sector and the transportation sector but we did some pull outs just so you could see what that might look like. This is the same set of categories we went through on the slide before and you can see how they map out in terms of their importance to the tonnage reductions in achieving some total level of reductions and then you can see by looking at the left hand axis the estimated cost savings per ton. So again the height of that step corresponds to the price tag and the horizontal stretch of it corresponds to how many tons are potentially available from that action area. This is a combination of costs per ton and supply potential in a stepwise cost function.

We saw the McKenzie supply curve at the last meeting as well. That is similar in structure and this is split out in steps the same way. I would also just note in the bottom axis we have a number of percentage numbers go from 0 to 50. This is the percentage reduction beneath BAU business as usual baseline emissions in 2020. So you go all the way out to the far right and at the 1990 level where we have an arrow that is approximately a 47 percent drop below BAU business as usual in 2020 and that would return North Carolina emissions to 1990 levels. That tops out on the high end at roughly $25 a ton. You slide back all the way to the arrow that says 2000 that is a 30 percent drop below business as usual and that would get you back to 2000 levels. In terms of the establishment of goals and targets they typically have been structured in terms of an index year say 1990 and then a future year and a percentage reduction target against that and so we see that here just for purposes of illustration I put 1990 and 2000. That can be converted to a percentage drop below business as usual which is the bottom axis there. We have not pulled together the benchmarks from other states in terms of the percentage drop below BAU. That is easy enough to do but they cluster somewhere below the low 30's to the high 40's. The low to upper 30's tend to be typical of northeast and west coast states the coastal economies and the higher percentage drops tends to be associated with higher growth states, primarily because of energy efficiency opportunities. Again two different ways to look at targets, the percentage you drop beneath the projected baseline and then the anchor point, the start year and then the index point that you need to get to beneath that. We are not going to spend a lot of time in terms of slide presentations, goals and targets but I did want to connect the dots in terms of the how mathematics of that are derived.

I color coded the general categories we went through earlier and profiled their total contribution to the reductions that were identified through the CAPAG process so you can see their percentage of importance just based on the greenhouse gas reduction potential. And going from the red bar on the left all the way to the green on the right you can see their ranking. The first two are in the heat and power sector, the first dealing with efficiency and the second dealing with the supply side issues. And we get into three bars that deal with transportation – the first is location efficiency, the second is vehicle operation improvements and then the third is the transportation fuels category. The next is land protection and conservation – the vast majority of which you will see in a minute is in the land protection and restoration category, then the final smallest category with waste recovery. These are aggregations of the options and certainly judgment calls have been made in terms of this particular format but this gives you some sense of the relative importance of these schematic areas. We also have information for their cost or cost savings per ton and that moves from left to right with the red bars going beneath zero that means the potential costs savings. The yellow bar going above zero which means potential net costs and we work our way across and see that we have the most significant cost savings opportunities on the efficiency side for stationary sources. And then vehicle operation improvements the judgment call by the group and we made an additional judgment call on location efficiency was partially quantified that we don't have a cost per ton figure here. Some qualitative decision that was made on some of the major issues they were to note that they are expected to have a net savings level that is significant but not fully quantified so on this slide we don't have a figure for location efficiency but it would be expected to be a savings.

Finally in this upfront profile we see total cost or cost savings estimated and I may have actually made an error in the 2007-2020 year and I think it is actually 2008 in term of the calculations that were used. But this is the net present value of either direct costs or direct savings associated with

the actions in these categories. Some of them expected to achieve significant net savings others would involve significant net costs. I am not going to spend too much time on the next two graphs except to note that the supply curve, this is another rendition of the supply curve which is just cost per ton and all of the different options in the CAPAG can be placed on that curve and categorized so that the supply curve that we showed at the outset is a combination of this data. Then the next slide as well which shows the greenhouse gas reduction potential and individual options. Again they have been categorized but certainly important to note that the very first option here ES2 portfolio standard has already been the subject of legislative agreement and has been signed into law. In this analysis the option that is shown here actually is for a scenario that would go above and beyond that and it I think raises an important point to bear in mind as we go forward and that is the certain amount of actions has already occurred in the recent few months and it's likely to occur this year. We are seeing some reduction already of emissions in North Carolina either from federal or state action and that is likely to continue and be a factor in planning going forward. Just so you know some other key things that are not included in this analysis because of the timing of the CAPAG process – the numbers that we've developed do not include the impact of the recent federal energy legislation which includes some important energy efficiency measures. Incandescent light bulb standards effectively a phase out and the new automobile standards café some other key things and we're in the process of producing updates from recent federal actions and translating them into the impacts on the overall forecast of emissions for all states and including North Carolina. Clearly they will have a depressing effect on the overall growth rate but they are not included in what I'm showing you today.

The first category heat and power – what we see here is a yellow and a red wedge against the economy wide growth on emissions from 1990 to 2020 so you see very significant reduction potential associated with both of these areas. Again just to note, the portfolio standard has already begun implementation of a significant slice above because of the structure of that particular standard. We profiled the potential for the individual CAPAG options that are included in these two categories and label them so you can see what's inside the box and how that fits together. These are all schematically similar in terms of being demand side actions but certainly there are some differences between them. But this is what is what is in the red box if you will. Cost per ton cost or cost savings this is one that shows a number of cost savings measures that came out of the process the energy efficiency and conservation arena for heat and power. Again this is reflected in the summary supply curve we showed at the very beginning.

The next set are the supply side actions in heat and power which involve a series of actions that have been labeled here that deal with the reduction and emissions associated with the production of energy whether it is generation of electricity or direct fuel that are used for buildings manufacturing, industrial processes, residential use etc. The big ticket one that stands out on the far left is the portfolio standard. We have the cost savings profiled for this set it's a combination of a few that are expected to yield cost savings and others that are expected to be on that positive cost. We pulled out just for purposes of illustration to lead by example actions for - I believe these were state government as opposed to local government but they include both energy efficiency requirements for (inaudible) green power purchasing. Obviously, the design of these individual options varies depending on what they are – some are oriented towards public agencies and state and local government and others towards the private sector. So this is just one illustration of being able to pull out one set of things that relate to one set of end use implementation. Cost per ton

here again the efficiency measures expected to result in significant cost savings and the positive cost associated with green power purchasing.

The next category is transportation and working our way down from the top. The top slice is the fuels category, clean and renewable fuels, the next slice is vehicle operations improvements and the next one is location efficiency. Pretty significant when you add these up in terms of overall emissions reductions. The profile here shows big ticket items in terms of land use practices and (inaudible) transportation, etc. but it is a collection of very big items and then some smaller items. Then the cost per ton, the estimates here are potential savings and again there were some fairly significant discussion about exactly how to handle quantification for some of these so that's carefully worded in the text of the report and reflected in the numbers.

The next category which is improvements and vehicle operations shows on the left the California Clean Car Standards and Diesel Retrofits and a much smaller category with Idle Reduction. That first category is important to note that since the process concluded we've seen federal legislation paths for a new café standard and it was certainly the result in a portion of that set of estimated reductions happening under federal law. The estimated costs or costs savings associated with these, actually looks like this draft didn't work right, this is a repeat of the previous draft. My apologies, we are missing the costs per ton data but I can look that up. In the fuels category the graph is missing for that also. We can go to the data and get the profile on that as well.

The Farm and Forest Conservation category you see a blue wedge here that deals with land protection and you really can't see the smaller wedge dealing with soil carbon because it is so small which doesn't mean it is unimportant, it certainly was important enough within the CAPAG process to become a final recommendation. But the Land Protection category is responsible for roughly ten percent of the CAPAG reductions – this is consistent with national averages in terms of the estimated potential for terrestrial sequestration from these kinds of activities. A profile again we see on the left the forest protection, forest enhancement measures are much higher ranking than the bar on the far right which is the preservation of agricultural work land. Then the cost per ton is also high for that last measure of the agricultural working lands. So it happens to be one that is both low in potential and relatively high in terms of costs but again not necessarily indicating that it is not a priority.

Recovery and Recycling is a smaller wedge and deals with the combination of land fill methane and biomass energy recovery programs and manure digesters and then recycling infrastructure and collection. The first two are oriented toward waste energy recapture. The cost profile here shows pretty significant difference with the manure digester options. This may well be one that fits into the category of having significant co-benefits because of waste reduction and the process of setting priorities and making final recommendations. Co-benefits and co-costs were one of the design criteria and decision criteria that the group could consider and this is one where that was important. The final graph is just going back to where we started from originally in the CAPAG process which was looking at the approach to the working group structure and the policy actions by economic sector and we've rearranged that a little bit based on the actual outcomes of the process but it tracks roughly with the overall sector breakdown. Again, some differences a little bit more splitting and then you can see the relative magnitude of the CAPAG recommendations against 1990. The recommendations would not quite return emissions back to 1990 levels but relatively close. The table that we've put together as a back up for this provides the same profiling and a

little bit more detail in terms it lists the specific CAPAG component actions that are in each of these action areas and the tonnage reduction potential costs savings cost and cost per ton. We've also added an additional metric year in response to a request that comes up very frequently which is an energy savings calculation and so we've listed that where it is applicable. You can see on the first item heat and power 1A Energy Efficiency and Conservation the estimates in terms of BTU's and giga watts per year, etc. That is one additional piece of information that we pulled out of the data in the full report. The final column here is a set of notes that relates to potentially key issues that would need to be considered in formulating either legislative or administrative action in implementing this action area. That is the overall brief.

Mr. Garrou: Thank you. Questions?

Ms. Preyor: Thanks so much for trying to pull this together in a new way for us to look at it. I just want to play back and see if I understand? If I say to myself, one of the questions that the Chairs have said to us, you know it's narrowing down, is this correct what your charts are saying that if I had to name the top four categories to get the most greenhouse gas reductions and how they relate to cost, is this what I heard that #1 in reductions and in costs savings is efficiency, #2 in reductions was the renewable energy but there were a lot of high costs on that one and that one is underway to some degree now; 3rd and 4th were transportation and the land protection category and they had a mix and a range of costs savings and ones that had positive costs and that the mix in there you can pick and chose on (inaudible). Is that a fair real lay person's look at that?

Mr. Peterson: Sure. This is a mixture but right off the bat in terms of where the tons are the stationary and mobile source sector, not surprisingly is where the tons are. And not insignificant are the tons that come along with land protection and conservation area but that is the short story on where the tonnage reductions are. The costs or cost savings map out generally but not exclusively following the man side reductions which is the net which is very important are the ones that show typically the highest potential for cost savings. The supply side actions are the ones that generally show some sort of positive costs. Obviously when you package them both together you are able to balance that out. The other important thing is that many of these options were structured deliberately anticipating that there would be integration within the sector of supply and demand side issues. So these were not envisioned as being entirely stand alone and one of the things we struggle a little bit with in putting this together was splitting out the demand and supply side for the sectors because they were really viewed in a much more integrated fashion in terms of actual implementation.

Representative Harrison: I don't mind asking stupid questions. Can we go to the last slide? I'm having a hard time understanding precisely what on the emissions reductions and you're talking metric tons of carbon emissions?

Mr. Peterson: These are equivalent so this would include not only carbon dioxide but methane (inaudible) and then the synthetic acids so this is all the gases that are recognized internationally and nationally.

Representative Harrison: So we don't have that translated into how it is going to work out as far as the parts per million, the 385 figure or their correlation?

Mr. Peterson: If the goal is to achieve 450 parts per million by 2050 or some point in the future which is certainly one of the recognized and now scientifically recommended benchmarks in terms of getting there from here. The question is whether any early benchmarks like 1990 levels by 2020 or 2000 levels by 2020 whatever it is, is on the pathway for stabilization for whatever that jurisdiction is. This is clearly on that pathway although if we were to stretch the right side of this from 2020 all the way out to 2050 you would see that this would need to go down fairly steeply in the arena of 70 percent maybe 80 percent reductions against 1990 or 2000 levels. So it would need to slope even further down but this is a pretty consistent level of effort in terms of being in a position to achieve the longer term reductions.

Representative Harrison: So that has a strongest reductions you mean?

Mr. Peterson: This kind of level of effort certainly has been viewed as consistent with that yes.

Dr. Andrews: Is there a background report that is available to us that that includes a little bit more of the detail about what specifically makes up each of the wedges? Each of these pieces clearly has assumptions behind it about how you achieve that full level that you are assuming we'll get to.

Mr. Peterson: If you will go to the project website for the CAPAG which is ncclimatechange.us the draft final report is posted with a series of chapters and appendices. They go into all of those details and the appendices contain the long form of the write ups for the individual policies and all of the details that was associated with that and that's many hundreds of pages but you can zoom in on any particular individual action and it is there. What we've got here is aggregated that detail, the write up is something a little bit more summary oriented.

Mr. Garrou: Dr. Andrews you missed the part where we got all the detail and asked for this. Other questions of Mr. Peterson? Thanks very much this was a good summary of what we've seen and I think this will be helpful to the Commission. Our next speaker is Mack Pearsall who is an Advisory Board Member of the Centers for Environmental and Climatic Interactions. Thank you for coming Mr. Pearsall.

Mr. Pearsall: Thank you Co-Chairs Garrou and Harrison for the opportunity to appear before the Commission. I am a member of a group of that called CC which is the Center for Environmental and Climatic Interaction and I provide user incentive for environmental and climatic interaction. It is a 501 C3 based in Asheville. You probably heard from me a month or so ago when we couldn't get on your agenda I sent you a CD about climate alive which really tells you a lot about what's happening in Asheville. But I want to bring it down to more of a street level and share with you what we're doing in Asheville and I want to bring you a proposal about how to get the water to the end of the road so to speak in terms of climate change and the measurement of particularly mitigation and adaptation opportunities for cities in North Carolina with Asheville potentially taking that lead. Now I am passing out a notebook here (**Exhibit F**) and I will simply direct first your attention to the cover of it which we see climate change, we've adapted to the fact that climate change is a scientific fact and we see this big red cloud over top of may the earth with somebody sleeping in quite repose and it is something that we've got to deal with. And we are going to propose to you what I call the creation of the North Carolina Green Cities Plan. I am going to ask you in a moment to turn to the Executive Summary page and from then on I am going to direct you to the appendices and very quickly try to document the reasons we are proposing it. We went back

and researched the basis for your being and under your duties and responsibilities I find under Section 5D an evaluation of economic opportunities for the state and they result in the international and national and state actions on to address climate change and emerging global carbon market. I am here today to talk about that so if you would turn with me to tab 1 and I want to tell you where we are in Asheville and why we are there. We are in the part of the state where we've lost tremendous number of manufacturing jobs. We've been trying to find a position in the 21st century that wasn't offshore that was authentic and was organic to us and the one that we could leverage with a sustainable competitive advantage and the Asheville hub was created as a catalytic group to find those particular opportunities. And we found a lot of opportunities another one we're working on beyond climate is the area rejuvenation and the integration of complementary and (inaudible) medicine which again comes back to part of what we're doing here in dealing with climate. What I am here to talk to you about today is what we're doing at CC in terms of this climate interaction. We realize we couldn't do it by ourselves so if you would turn to tab 2 and turn your notebook sideways and look at exhibit A. You will see that we have been building relationships with a lot of people and in fact I just came from Erskine Bowles' office. When I was there with the head of the NOAA operation here in North Carolina, NCDC I was there with people from Oakridge National Laboratory, I was there with all of Erskine's people who are planning their curriculum and looking for their graduate programs and all of that. We've got a relationships wherever you see a star in a box we already have an existing relationship with that. One of these you may well know about is the RENCI engagement site which comes through UNC-Chapel Hill. I'll talk about that as a way to anticipate and plan for interactions against catastrophes. But we've had to go to a lot of different places and we happen to have those relationships naturally in place – Oakridge is very close to Asheville. We already have an engagement with them through our AB Tech. The NOAA we have the National Climatic Data Center there and we have the US Forest Service. We are working at their special lab in doing a lot of research and modeling. We have a lot of private sector companies that are coming to Asheville to monitor weather and say how do you monitor it, how do you take it and turn it into something that is market driven that people want to buy the results of your information. And we think that the Department of Energy over at Oakridge and the Department of Defense in many areas have now been mandated to find out they have got to plan climatic interventions or climatic situations into their planning processes. We have a lot of local activities – well that's a relationship we couldn't do by ourselves.

Now the relationship we are talking about with you and what we are proposing, if you will go back to the first page and then we'll go to Appendix A1. We would like to propose to you this, the establishment of a partnership with the state of North Carolina, the University of North Carolina, the Nicholas Institute of Environmental Solutions, national foundations and others to develop and establish a North Carolina green cities plan to initiate test and validate climate change management initiatives and urban climate environment and to designate Asheville as that prototype place where it should be started. I'll give you the reason we think that which will help to solidify our position in the National Climate Change market. Now climate change is affecting everybody's life. What DOD is very concerned about it and when we're talking to people in Europe about moving vineyards north because they know they will not be able to grow grapes in a certain part of the world it affects everybody's life. Now what do we have in Asheville going on? We got the National Climatological Data Center that has six decades of records on daily information coming in from all over the world and the United States about what's happening in climate. We have nine Noble Peace prize winners who are at the International Panel on Climate Change, the one for which Al Gore won his Nobel Peace prize, this intellectual capital that we find at Asheville

and we plan to make use of that intellectual capital and the assets of NCDC and that data base there. Now there are people all over the world who are predicting tragic circumstances and the time to intervene is now. We believe also that the time is now to act because we know there is going to be a lot of federal money spent on research in the climate change area. We had the National Climate Change Data Users Conference in November and over 200 people were there. We had re-insurers, we had transportation people and we also had energy people. It is amazing how those people are concerned about what is happening in their industry. I never thought on transportation but I drove into that storm last night from Asheville and I don't know if you believe in climate change, whether it was coincidental or not but what they are telling us is we are going to get the same levels of precipitation but it is going to come in much steeper peaks like that and when spike in heating and fighting cold it will call early metal fatigue in bridges. Who would have ever thought about the climate change implications from that type of thing? We had that users' conference there and the market is going to be unbelievable. Now it is one reason we are all struggling with exactly how it is going to come about because it is a brand new market and there are a lot of unknowns in it. But we know there is a great desire for an honest broker of climate information. As an attorney I can tell you I can buy conversation and information expert testimony on either side of the case but I'm telling you these people are in industries where they are trying to make long term and capital investments and they don't want to be off the mark in making it. If you're going to give them that type of information you need highly sophisticated scientific input and you are also going to need different types of technicians. How big is the market? Right now it is a 2-4 billion dollar market; in ten years we think it will be a 10 billion dollar market in less than ten years and we think there will be a 500 billion dollar private sector spin off and that is where Asheville is trying to position itself.

Now if you will look back to the Appendices look at Exhibit B. These are predictions that have been made by our experts on the type of money that is going to roll out of this entire industry as a development – a brand new industry. The only thing that I would point out here is I don't understand all of the sophistication behind these formulas but at the bottom next to the last dot that says weather affects only 30 percent of the GMP but climate affects 100 percent of the GMP. Exhibit B, Appendix B is behind Section 2, Tab 2 and the Appendices are alphabetical. This substantiates what we think will be the gross of the industry and how much it is going to mean to a community that is trying to find a position in that market. We need to act now because there are others who are involved in this. Colorado is involved in this, Maryland is involved in it and others are attempting to get involved in the cold climate change management initiative and the management of that data. We've chosen specific markets for Asheville – one of our specific markets is to take climate change data and model it for public policy decision makers at the state and local level. This would be cities and counties that say what would this information mean to me in terms of what type of policies I should be initiating? Well if you look over at C and C1 in the Appendices you want to know why I say it should be done in Asheville.

We've been about it for five years folks, we've already had this HUB organization that's a catalytic organization, we've got the Center for Environmental and Climate Interaction because they already actualized our plan for North Carolina Aubrietrium and taking a lead in it we've got our own education research program going. We've got an applied visualization lab – our concept is that people are not literate they're alliterate – they would rather see a picture than they had to see very complex scientific data and if you're going to convince people as a reason for change in the way they behave or to understand something from a policy standpoint, you are going to have to paint

them a picture. We've got a growing media arts community that is basically our ability to merge the media artists with the computer artists and to convey that particular story. So we've got great opportunities going – we've not been asleep if you look at Section C1 Why Asheville should do it – why Asheville should be chosen as the boggy. If you will look here under C1 there are 78 reasons why Asheville should be chosen. You start off with our municipal situation where we are member of the cool cities agreement, one of the first people on the east coast to do that. We are members of ICLEI we are the only city on the east that has a Gold Leed standard for all of our municipal buildings. We've entered into carbon reduction agreements. We've got the (inaudible) engagement site with a decision wall and a completely immersive environment which we think is a new economy approach to teaching climate change and issues. We've had NOAA come in two weeks ago and said you are doing exactly with climate change information what you need to do to be sold to the market place. What we're doing is market driven – if you are familiar with GIS actives and (inaudible) the president of (inaudible) is very intrigued with what is happening in Asheville. He is coming to Asheville to see what we're doing because he thinks that type of information should be rolled nation wide.

We pride the greenest city but you are not going to find many cites in the state that are making eating utensils out of potatoes. We are in to all sorts of green things we have the Green Building Council We have our own American Green TV You Tube, (inaudible) Company that is started in Asheville. We have over 80 green buildings - the Biltmore House has initiated all sorts of green initiatives. We are home to the organic growers' school. We got an eco agents' deal for our realtors. Folks we are green and there are 78 reasons in there that will tell you why Asheville should be chosen as the place to initiate this plan. We haven't been asleep, look at D we've been planning this for years and it is finally coming to fruition. Even this morning as we speak, there is not going to be one National Climate Center, there is going to be a National Climate Services Network – Asheville intends through NCDC and through our civic efforts to make us a large node on that particular network and we're choosing visualization, policy making data and we are also have relationships with the Department of Energy and the Department of Defense. There is 74 million dollars in the federal budget, 3.4 million which is going to come to Asheville to manage a satellite operations program for earth observation. What is happening is the scientific part of this observation is over and now we need to move into the measurement of earth observation data for the purpose in terms of mitigation and adaptation procedures. So I come to the bottom and I say ok again we want to establish the partnership with the state of North Carolina, national foundations and others to develop a green city plan to test and validate management initiatives and urban climate environment and have Asheville designated to (inaudible). It is going to be a lot of snake oil, folks are going to be asked to do this and do that, we think we have the environment with the potential for the International Climatological Data Center to measure our intervention and validate it and be a place that people can come and be instructed on how to take the information that is in the academy and get it to the end of the road where it makes a real difference in real people's lives.

All that said, if you will flip over to Tab 3 I think there is a pit factor. I think it is a pit factor in Asheville and that it has a national bug about it and if you'll look at the PR pieces that we have behind there about how Asheville has become a venue for climate change. Our politics is liberal enough where we can undertake this type of thing and small enough and the last thing to be designated as that particular city where we try the green cities program would fit us because that is what we are. We are sustainable and we live in that world. I was just given this morning out of Popular Science America's 50 green states. Greensboro is the last one listed on there the best

one is in Oregon. They measure it in different ways from transportation to energy use to all sorts of other forms of reductions. What I say to you is we propose that we take all of the findings that you come up with and create an actual plan to get the water to the end of the road and we propose that Asheville will be that place and volunteer to serve with you and we have an action plan here. If you will look at Appendix F in item 3, the last thing in item 3, we are recommending that this Commission help us create the clean cities plan to encourage all cites in this state to work on reduction of greenhouse gases. We are hoping that you will encourage the Legislature to appropriate funds to create an urban green lab and that Asheville will be designated as that. We are committing ourselves politically to get our delegation behind it because we think that the science needs to be moved to the street where action can take place and we can change people's lives and change the impact through adaptation or through mitigation. That is our proposition and I hope you will do something with it. Put it in your records but we're here to let you know that we're a player in the climate change industry and we're already off and gone. We staked that territory out and we're actualizing on it and we think that in North Carolina if we're going to make a difference in the greenhouse emissions in the cities perhaps a green cities program would be the way to do it and we would offer ourselves as a candidate for that proposition.

Mr. Garrou: Thank you Mr. Pearsall. Questions? Thank you very much for that presentation.

Mr. Pearsall: Thank you and the books are being handed out and we'll leave extra books with the secretaries to give out.

Mr. Garrou: Before I open the floor for any discussion let me suggest to you what Chairman Harrison and I consider to be the agenda for the next two meetings. The first will be to consider whether and in what form to recommend a statewide goal for greenhouse gas emissions reduction. The second would be whether and to what extent to adopt the final CAPAG report as the position of the Commission. And the third would be to consider whether to recommend to the Legislature in the short session any particular form of legislation. The next two meetings in our view should be devoted to those three categories for action. Discussion?

Representative Underhill: Thank you Mr. Chairman and also Chairman Harrison. I think this is a point where we do need to seriously assess the information that has been provided to us and provide the Legislators who are serving on this Commission with a plan of how we want to proceed in the short session and then in the long term reinstating ourselves for another year for the long session where further legislation can be proposed. We have a lot of things that has been presented to us and I think we need to prioritize the key most vulnerable things that we need to do first. Since I fit in a district that may be under water some day soon from what I'm hearing I certainly am extremely concerned with the adaptation items we were presented today. But Dr. Riggs has said over and over and I would particularly want us to have some sort of strategy to begin to address adaptation and sea level change. I do not diminish the importance of all of these other things but we're really moving forward quickly the state is embracing the importance of greenhouse gas emissions on all the reductions of that waste. I don't believe that people in the state and even people in the east where I live understand the importance of what could happen in the next 50 to 100 years. With a very critically important economic driver in our state historically and I really want to reiterate how important I think this is for us to concentrate in this first wave of information to the General Assembly what Dr. Riggs has brought forward today particularly with the

piece of legislation that we will be faced with addressing immediately when we get there how do you deal with (inaudible). Thank you.

Mr. Garrou: Thank you – other questions or statements? If not we are adjourned and will see you next time. Thank you very much. Let me remind you to turn in your expense reports.

Meeting adjourned at noon.

Respectfully submitted,

Representative Pricey Harrison, Co-Chair

Thelma Utley, Commission Clerk

Mr. John Garrou, Co-Chair, Presiding

APPENDICES

Exhibit A	Visitor Registration Sheets
Exhibit B	Agenda
Exhibit C	Memorandum (Nicholas Institute for Environmental Policy Solutions) Duke University
Exhibit D	A Call For Action – Jane Preyor
Exhibit E	Draft Consolidated CAPAG Options – Tom Peterson
Exhibit F	The North Carolina Green Cities Plan – Mark Pearsall

VISITOR REGISTRATION SHEET

Legislative Commission on Global Climate Change — 03/05/2008

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Sonna Steene	Hunton & Williams
Sharon Miller	CNCA
KRIS CORACINI	EDF
JOHN SHAW	
Russ Dubisky	IFNC
Beth Brown	Exploris Middle School
Luke Brown	Exploris Middle School

LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE
2007-2008

2007-2008 Membership

Session Law 2005-442, which established the Legislative Commission on Global Climate Change, provides that the Commission shall consist of 34 members. 18 of these members are appointed by the President Pro Tempore of the Senate and the Speaker of the House of Representatives as indicated below. The remaining 16 members are ex officio voting members designated as indicated on the second part of this membership list.

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Ulla Reeves	So. Alliance for Clean Energy
Leslie Kleczek	Nicholas Institute, Duke University
Grady McCallie	NC Conservation Network
Erin Kinney	NC conservation Network
Bill Crowell	Albemarle-Pamlico National Estuary Prg.
Dean Carpenter	Albemarle-Pamlico National Estuary Program

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AGENDA

10:00 a.m. Wednesday 5 March 2008
Room 643 Legislative Office Building

1. Call to order
   John. L. W. Garrou

2. Introductory remarks by Cochairs
   John. L. W. Garrou
   Representative Pricey Harrison

3. Report to the Commission and explanation of agenda items
   George F. Givens, Commission Counsel

4. Presentation of the recommendations of the Climate Action Plan Advisory Group (CAPAG) (Consolidated format)
   Thomas D. Peterson, President and CEO
   Center for Climate Strategies

5. Presentation of options for State and local governments to consider with regard to plans for and adaptation to the impacts of global climate change
   William E. Holman, Visiting Senior Fellow
   Duke University Nicholas Institute for Environment Policy Solutions

6. Presentation of the "North Carolina Green Cities Plan" by the Centers for Environmental and Climatic Interaction
   Mack B. Pearsall, Advisory Board Member
   Centers for Environmental and Climatic Interaction

7. Commission discussion and announcements

8. Adjourn

SCHEDULE OF FUTURE MEETINGS:

The Cochairs and Counsel have established the following schedule of meetings of the Legislative Commission on Global Climate Change for the 2007-2008 Legislative Interim. Except as noted, all meetings are scheduled for 10:00 a.m. This schedule is subject to revision.

Commission Meeting	Location
Tuesday 22 April 2008 (Note change in date)	643 Legislative Office Building
Wednesday 7 May 2008	544 Legislative Office Building

COMMISSION WEBSITE:

In order to provide public access to the materials distributed at the meetings of the Commission and to other documents related to the Commission, a website has been developed for the Commission. The website can be viewed online at the following address:

http://www.ncleg.net/gascripts/Committees/Committees.asp?sAction=ViewCommittee&sActionDetails=Non-Standing_6268

ADDITIONAL INFORMATION:

Persons having questions about the Commission meeting or other matters related to the Commission may contact Commission Counsel or other Commission staff at (919) 733-2578.

NICHOLAS INSTITUTE FOR ENVIRONMENTAL POLICY SOLUTIONS
DUKE UNIVERSITY

Memorandum

To: The Honorable Pricey Harrison, Co-Chairman
Mr. John Garrou, Co-Chairman
Members of the Legislative Commission on Global Climate Change
From: Bill Holman, Director of State Policy
Nicholas Institute for Environmental Policy Solutions
Re: Options for Planning and Adapting to Impacts of Global Climate Change in North Carolina
Date: March 5, 2008

I am writing to respond to your request for options for state and local policy makers to consider regarding planning for and adapting to the impacts of global climate change.

Background

Concentrations of carbon dioxide in the atmosphere have increased from 277 parts per million at the dawn of the industrial revolution to 385 parts per million today and will likely rise to 450 parts per million by 2050. According to the scientists on the Intergovernmental Panel on Climate Change (IPCC) the global climate will continue to warm for a minimum of 90 more years even if the US, China and India join the rest of the developed world in capping, reducing, and offsetting emissions of greenhouse gases.

National, State and local policies to cap, reduce, and offset emissions of greenhouse gases and to stabilize the global climate should be adopted and implemented as soon as possible. However, national, State and local policies to plan for and adapt to the impacts of global climate change should also be developed, adopted and implemented as soon as possible. Unfortunately the US Department of Homeland Security's National Infrastructure Protection Plan ignores global climate change. State and local governments must begin planning for global climate change until a new Administration recognizes the problem and provides leadership and technical and financial assistance.

Impacts of Climate Change in the Southeastern United States

Global climate change has and will continue to have significant public health, environmental, and economic impacts on North Carolina. "Adaptation" to global climate change is occurring right now. The citizens of North Carolina are currently paying for beach nourishment projects, for major increases in wind and flood insurance, for bulkheads on the estuarine shoreline, and other costs.

Global climate monitoring and modeling have substantially improved over the last twenty years. Regional, State and local monitoring and modeling lag behind. The NC State Climate Center at NC State University operates 30 ECONet climate monitoring stations in NC.

In general scientists predict more extreme weather, including longer and more severe droughts and larger storms and floods for the Southeastern United States. Warmer air should produce more rain in the Southeast, but the rain may be delivered in more intense storms that produce more runoff and less infiltration and groundwater recharge. Water supply models, stormwater controls, wastewater effluent standards, floodplain maps, etc are all based on historical weather data and may have to be reevaluated.

"Stationarity is Dead: Whither Water Management" in the February 1, 2008 issue of *Science* reports that a fundamental aspect of water resource management has been that natural systems fluctuate within certain unchanging boundaries (stationarity). The assumption of stationarity must be replaced as global warming changes the means and extremes of precipitation, evapotranspiration, and rates of discharge of rivers. *Science* reports "Rapid flow of climate-change information from the scientific realm to water managers will be critical for planning, because the information base is likely to change rapidly..."

Hotter weather increases evaporation from water supplies and stresses both crops and landscaping. It increases demands for electricity while at the same time decreases the ability of (warmer) water to cool coal and nuclear-fired power plants. Hotter weather and warmer waters could increase nuisance algae blooms and fish kills. Hotter summers could increase unhealthful levels of ozone pollution.

Over 1.2 million acres of coastal NC are below one meter (approximately 3 feet) in elevation and are particularly vulnerable to sea level rise and storm surges. Scientists estimate that sea level will rise ½ meter (1 ½ feet) or more in the next 100 years. A recent study by economists at Appalachian State, Duke, East Carolina, and University of North Carolina at Wilmington estimated that the value of property at risk to sea-level rise in just four NC coastal counties to be $6,900,000,000.

Rising sea level will increase coastal flooding, erosion, property damage, and salt water intrusion. Saltwater will move further upstream in coastal rivers and further inland into coastal aquifers. The saltwater wedge may threaten existing freshwater intakes and supplies and may make some agricultural and forest lands unproductive.

Wetlands provide many ecological services such as water quality, flood storage, habitat, and storm protection. Wetlands may also be able to migrate with rising sea level if they are not blocked by a hardened estuarine shoreline.

Options for North Carolina Policy Makers

<u>Inventory Existing Federal, State and Local Programs</u>

- Many federal, state, and local agencies, including US Department of Homeland Security, Federal Emergency Management Agency (FEMA), US Army Corps of Engineers, US Department of Agriculture, US Environmental Protection Agency,

NC Department of Crime Control and Public Safety (DCCPS), NC Department of Environment & Natural Resources (DENR), are "adapting" to global climate change without principles or a comprehensive plan in place.

- Inventory existing federal, state, and local disaster planning and response programs, environmental planning and management programs, and economic development planning programs, including their budgets.
- Identify conflicting policies between programs and barriers to adaptation.

Develop and Adopt Climate Adaptation Goals and Principles

- Develop and adopt climate adaptation goals and principles to guide public and private decision makers.
- Utilize the consistency provisions of the Coastal Area Management Act and federal Coastal Zone Management Act to help resolve conflicts between existing policies and programs.
- Amend GS 113A-1, State Environmental Policy Act (SEPA) to add consideration of emission of greenhouse gases, climate change, and sea level rise to issues that must be addressed in environmental documents.

Improve Climate Data and Research

- Increase ability of State and local governments to predict impacts of climate change, drought, floods, and weather by appropriating $500,000 per year to NC State University to expand and maintain NC State Climate Monitoring Network (ECONet) from 30 sites to sites in all 100 counties.
- Make NC a national center for both climate research, adaptation, and the emerging carbon market by establishing a public-private university climate research consortium (like the successful Water Resources Research Institute (WRRI)) and by appropriating $3,000,000 to University of North Carolina system. Capitalize on existing institutions including but not limited to National Oceanic & Atmospheric Administration's (NOAA) National Climatic Data Center in Asheville, Asheville's Centers for Environmental & Climatic Interaction, UNC-CH's atmospheric modeling program, Duke University's expertise in climate/energy policy and the emerging carbon market, and the new multi-university Center for Natural Disasters, Coastal Infrastructure and Emergency Management based at UNC-CH.

Plan for Droughts and Extreme Weather

- Direct DENR and the State Water Infrastructure Commission (SWIC) to work with NC League of Municipalities, NC American Water Works Association/Water Environment Federation, the engineering community and

others to provide technical and financial assistance to public water, wastewater and stormwater systems to plan for hotter temperatures, droughts, intense storms and extreme weather and appropriate $500,000 for this purpose.

- Amend GS 143-355, the Water Planning Act of 1989, and GS 130A-311, the NC Drinking Water Act, to standardize the definition of "Safe Yield" for water supplies, to ensure that public and private water suppliers plan for global climate change, and to enable Division of Environmental Health to consider safe yield when reviewing plans for drinking water systems. The NC Utilities Commission should also consider safe yield in its review of private water systems.
- Build upon DCCPS's "Storm Ready" communities program and establish a "Climate Ready" communities program. Provide incentives to Climate Ready communities such as insurance premium discounts and favorable consideration for state financial and technical assistance.

Plan for Sea Level Rise and Intense Storms

- Amend GS 113A-100, Coastal Area Management Act (CAMA) to require Coastal Resources Commission (CRC), Division of Coastal Management (DCM), and local governments to consider sea level rise when approving land use plans and major CAMA permits. Authorize use of coastal management grants to local government to plan for and adapt to sea level rise.
- Increase protection of coastal wetlands and their ability to migrate inland by directing the Coastal Resources Commission (CRC) to prohibit new bulkheads and hard structures in "critical wetland protection areas" or "areas of environmental concern." Require DCM to report to the ERC annually on the loss of coastal wetlands due to estuarine shoreline hardening and other uses. Require applicants for permits to harden the estuarine shoreline outside of areas of environmental concern to mitigate their impacts on wetlands. Direct Coastal Habitat Protection Plan (CHPP) to plan for and adapt to global climate change and sea level rise. Increase funding for Clean Water Management Trust Fund (CWMTF) in order to protect and restore coastal wetlands.
- Retain NC's model law that recognizes that sea level is rising, beaches are moving and that prohibits new seawalls, jetties, and groins on the ocean.
- Direct the NC Albemarle/Pamlico National Estuary Program to review US Environmental Protection Agency's proposed "Climate Ready Estuaries" program and plan for and adapt to global climate change and sea level rise in its work.
- Provide maps of sea level rise to local governments, Realtors, conservation organizations, and the public via NC One Map.
- Improve coordination or consolidate and integrate State natural hazard planning & regulatory programs in DENR and/or the Department of Crime Control & Public Safety. Review effectiveness of existing technical assistance, financial assistance, mapping, and regulatory programs in DENR and DCCPS. For example floodplain management and stormwater management programs should be complimentary. Sea level rise planning and coastal management should be complimentary. DCCPS should retain primary authority for emergency response.

Mitigate Hazards

- Establish a NC Hazard Mitigation Fund to acquire either conservation easements or fee simple properties in floodplains and other high risk areas to protect the public, prevent property damage and lower risks before sea level rises and storms occur. Fund with appropriations from the General Fund, a surcharge on property insurance, a surcharge on high risk properties, and/or fee for filling or building in high risk areas such as 100-year floodplains. Insurance costs rise or insurance becomes unavailable after storms.

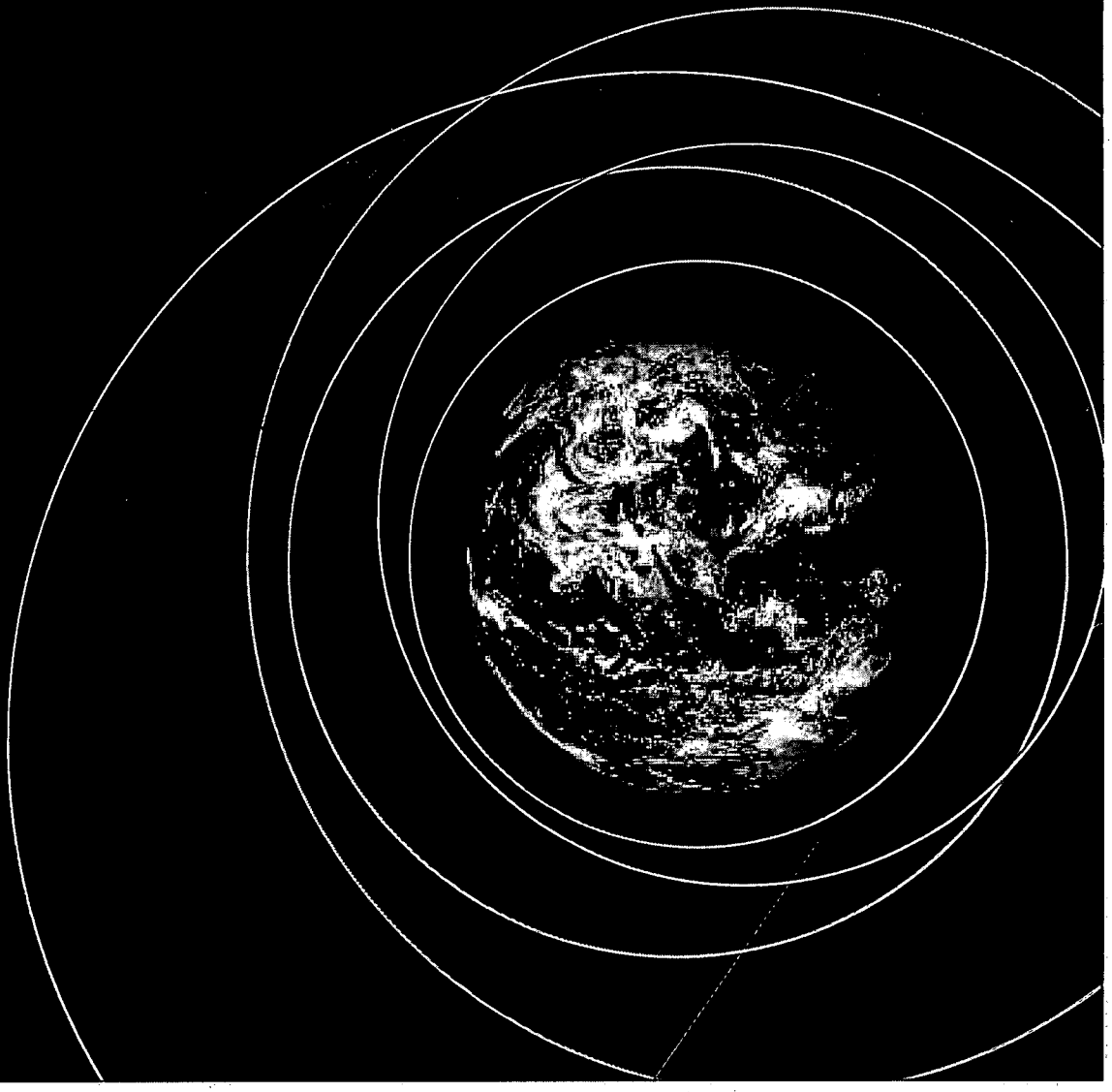
Thank you for your consideration.

Please let me know if you have questions or need more information.

USCAP
United States
Climate Action
Partnership

A CALL FOR ACTION

Consensus Principles and Recommendations
from the U.S. Climate Action Partnership:
A Business and NGO Partnership





USCAP
United States
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ALCAN
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CATERPILLAR
ConocoPhillips
Chrysler Jeep Dodge
John Deere
DOW
Duke Energy.
DUPONT
e environmental defense finding the ways that work
Exelon.
Ford
FPL GROUP

GE
GM
Johnson & Johnson
MARSH
National Wildlife Federation
NRDC
NRG
The Nature Conservancy
PEPSICO
New Century Global Partners
PG&E Corporation
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RIO TINTO
Shell
SIEMENS
World Resources Institute
XEROX

A CALL FOR

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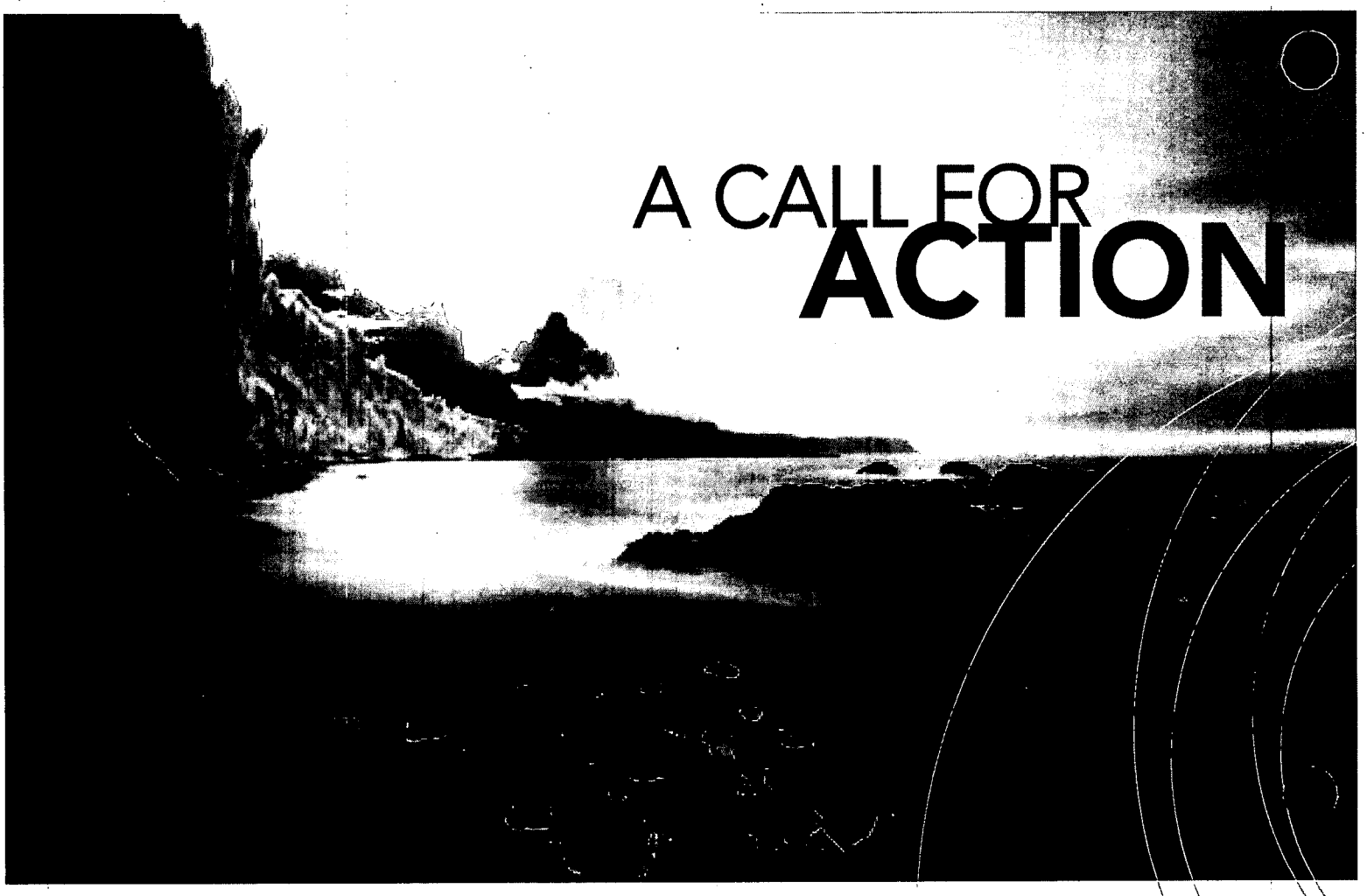
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04 Our Design Principles

06 Our Recommendations

11 Our Commitment

12 APPENDIX:
U.S. Climate Action
Partnership Members



A CALL FOR ACTION

We Know Enough to Act on Climate Change

In June 2005, the U.S. National Academy of Sciences joined with the scientific academies of ten other countries in stating that "the scientific understanding of climate change is now sufficiently clear to justify nations taking prompt actions."

Each year we delay action to control emissions increases the risk of unavoidable consequences that could necessitate even steeper reductions in the future, at potentially greater economic cost and social disruption. Action sooner rather than later preserves valuable response options, narrows the uncertainties associated with changes to the climate, and should lower the costs of mitigation and adaptation.

For these reasons, we, the members of the U.S. Climate Action Partnership (USCAP) have joined together to recommend the prompt enactment of national legislation in the United States to slow, stop and reverse the growth of greenhouse gas (GHG) emissions over the shortest period of time reasonably achievable.

Please see the Appendix on page 12 for a list of USCAP members and please visit www.us-cap.org for more information.

The Challenge is Significant, But the United States Can Grow and Prosper in a Greenhouse Gas Constrained World

The scale of the undertaking to address climate change is enormous, and should not be underestimated. For this issue to be successfully addressed—and failure is not an option—the way we produce and use energy must fundamentally change, both nationally and globally.

In our view, the climate change challenge, like other challenges our country has confronted in the past, will create more economic opportunities than risks for the U.S. economy. Indeed, addressing climate change will require innovation and products that drive increased energy efficiency, creating new markets. This innovation will lead directly to increased U.S. competitiveness, as well as reduced reliance on energy from foreign sources. Our country will thus benefit through increased energy security and an improved balance of trade. We believe that a national mandatory policy on climate change will provide the basis for the United States to assert world leadership in environmental and energy technology innovation, a national characteristic for which the United States has no rival. Such leadership will assure U.S. competitiveness in this century and beyond.

In our view, the climate change challenge will create more economic opportunities than risks for the U.S. economy.

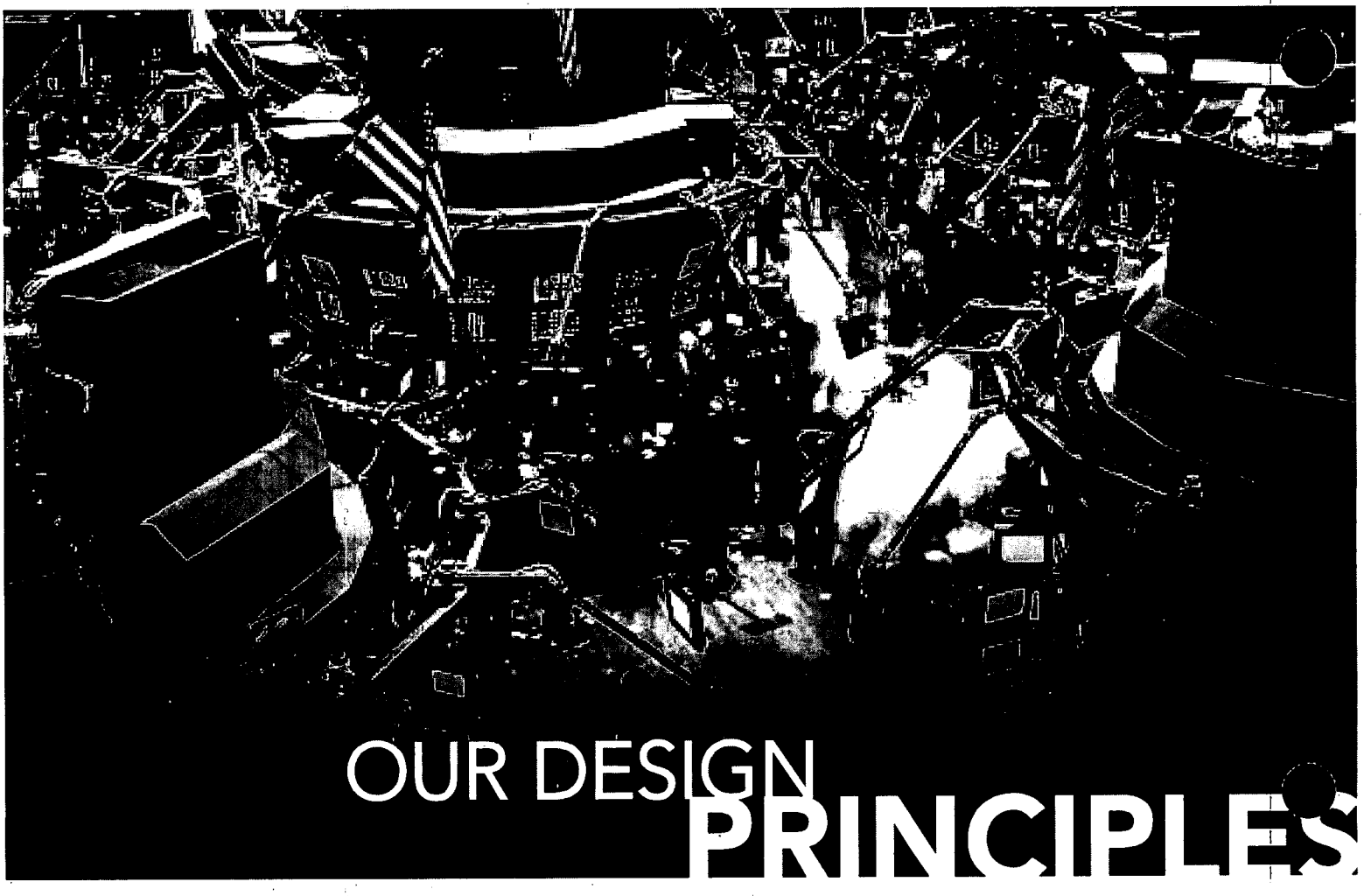
We Need a Mandatory, Flexible Climate Program

We believe a U.S. policy framework must include the following.

— Mandatory approaches to reduce greenhouse gas emissions from the major emitting sectors including emissions from large stationary sources, transportation, and energy use in commercial and residential buildings that could be phased in over time, with attention to near-, mid-and long-term time horizons;

— Flexible approaches to establish a price signal for carbon that may vary by economic sector and could include, depending on the sector: market-based incentives; performance standards; cap-and-trade; tax reform; incentives for technology research, development, and deployment; or other appropriate policy tools; and

— Approaches that create incentives and encourage actions by other countries, including large emitting economies in the developing world, to implement GHG emission reduction strategies.



OUR DESIGN PRINCIPLES

We believe U.S. Climate legislation must include the following design principles.

Account for the Global Dimensions of Climate Change

The effects of climate change are global, as are the sources of GHG emissions. Success will require commitments by all of the major emitting countries. Toward this end, the U.S. government should become more involved in developing the post-2012 international arrangements for addressing climate change that are now being discussed. While care should be taken that policies do not merely push emissions from U.S. facilities to overseas plants, ultimately there must be an international program for addressing climate change and its impacts. U.S. action to implement mandatory measures and incentives for reducing emissions should not be contingent on simultaneous action by other countries. Rather, we believe that U.S. leadership is essential for establishing an equitable and effective international policy framework for robust action by all major emitting countries.

Recognize the Importance of Technology

There are a number of technologies that are currently available that emit little or no GHGs, such as wind, solar, and nuclear power, hybrid vehicles, and numerous energy efficiency technologies. The cost-effective deployment of existing technologies to improve energy efficiency and reduce GHG emissions should be a priority, as it will yield emission reductions in the near-term while new technologies are developed. The most efficient and powerful way to stimulate private investment in research, development, and deployment is to adopt policies establishing a market value for GHG emissions over the long-term. Where near-term price signals are insufficient to deploy cleaner existing technologies, additional incentives or other measures must be considered, especially where carbon emissions could be significantly reduced and the "lock-in" of future carbon emissions avoided. Rapid advancement and deployment of new, breakthrough technologies are also core elements of any climate change solution. Thus, an effective climate change program must include policies to promote significant research, development and deployment of hyper-efficient end use technologies; low-or zero-GHG emitting technologies; and cost-effective carbon capture and storage, which will be particularly important in the deployment of advanced coal technologies.

Be Environmentally Effective

Climate stabilization requires immediate action and sustained effort over several decades. Mandatory requirements and incentives must be stringent enough to achieve necessary emissions reductions within timeframes that prevent an unacceptable level of GHG concentrations and climate change. We must start a program in the near-term that captures short-range reduction opportunities, puts us on the path to stabilizing concentrations, and preserves our options to avoid an unacceptable level of climate change in the future.

Climate stabilization requires immediate action and sustained effort over several decades.

Create Economic Opportunity and Advantage

Addressing climate change must be achieved in a highly cost-effective manner that allows for economic growth in both the developed world and emerging economies. A climate protection program must use the power of the market through reliance on institutional and regulatory structures that establish clear targets and timeframes. Requirements for reducing emissions may vary between sectors and should be designed to promote sustained economic growth and prompt, efficient action in the shortest time reasonably achievable, compatible with the goal of preventing dangerous human interference with the climate.

Be Fair

Some economic sectors, geographic regions, and income groups may be disproportionately impacted by both climate change impacts and mandatory GHG reductions. Any climate protection program needs to take account of these impacts and provide appropriate assistance to those disadvantaged or disproportionately impacted by such program.

Encourage Early Action

Prior to the effective date of mandatory emission limits, every reasonable effort should be made to reduce emissions. Those companies that take early action should be given appropriate credit or otherwise be rewarded for their early reductions in GHG emissions.



OUR RECOMMENDATIONS

Congress Needs to Enact Legislation as Quickly as Possible

We offer the following interconnected set of recommendations for the general structure and key elements of climate protection legislation that we urge Congress to enact as quickly as possible. The legislation should require actions to be implemented on a fast track while a cap and trade program is put in place, including the establishment of a GHG inventory and registry, credit for early action, aggressive technology research and development, and policies to discourage new investments in high-emitting facilities and accelerate deployment of zero and low-emitting technologies and energy efficiency. We recommend these fast track actions begin within one year of enactment.

The Environmental Goal

U.S. legislation should be designed to achieve the goal of limiting global atmospheric GHG concentrations to a level that minimizes large-scale adverse climate change impacts to human populations and the natural environment, which will require global GHG concentrations to be stabilized over the long-term at a carbon dioxide equivalent level between 450–550 parts per million.

Take a Stepwise, Cost-Effective Approach

While achieving our environmental goal will require a fundamental transformation of the energy system over the long-term, we cannot predict with accuracy all technological developments between now and 2100. For these reasons, legislation should focus on what we know can be cost-effectively achieved over the next twenty to thirty years while putting us on a trajectory for deeper emission reductions by mid-century.

Cap and Trade is Essential

Our environmental goal and economic objectives can best be accomplished through an economy-wide, market-driven approach that includes a cap and trade program that places specified limits on GHG emissions. This approach will ensure emission reduction targets will be met while simultaneously generating a price signal resulting in market incentives that stimulate investment and innovation in the technologies that will be necessary to achieve our environmental goal. The U.S. climate protection program should create a domestic market that will establish a uniform price for GHG emissions for all sectors and should promote the creation of a global market.

> We are committed to a pathway that will slow, stop and reverse the growth of U.S. emissions.

Establish Short and Mid-Term GHG Emission Targets

To begin the process of reducing U.S. emissions, we recommend Congress establish a mandatory emission reduction pathway with specific targets that are:

- between 100–105% of today's levels within five years of rapid enactment
- between 90–100% of today's levels within ten years of rapid enactment
- between 70–90% of today's levels within fifteen years of rapid enactment

The short- and mid-term targets selected by Congress should be aimed at making it clear to the millions of actors in our economy and to other nations that we are committed to a pathway that will slow, stop and reverse the growth of U.S. emissions. Furthermore, Congress should specify an emission target zone aimed at reducing emissions by 60% to 80% from current levels by 2050.

Complementary Policies and Measures Will be Necessary

Climate protection policies must be complemented with U.S. energy policies that result in diverse and adequate supplies of low-GHG energy. In addition, as described below, an aggressive technology research, development, and demonstration program, along with policies aimed at deploying low- and zero-emission technologies will be necessary to achieve our policy goals. In sectors that are insensitive to price signals and that face market barriers to the introduction or utilization of low or zero-emission technology, we recommend appropriate sector-specific policies.

Scope of Coverage and Point of Regulation of the Cap and Trade Program

We recommend the cap and trade program should cover as much of the economy's GHG emissions as is politically and administratively possible. We believe there are potentially effective approaches to achieving these objectives including the following.

- An "upstream" program that requires fossil fuel producers (or shippers in the case of natural gas) to be covered by allowances that equal the emissions released when the fuel is combusted, thereby adding the cost of the emission reduction allowance to the price of the fuel; OR
- A "hybrid" program that includes a downstream cap applied to GHG emissions from large stationary sources (e.g., covering 80% of the emissions from the fewest possible number of sources) combined with an upstream cap or another policy tool applied to the carbon content of fossil fuels used by remaining sources.

Emission Offsets

Legislation should permit entities subject to the cap to meet part of their obligations through the purchase of verified emission offsets from a range of domestic sinks, domestic sources of emissions that are not subject to the cap, and projects outside the US. The offset must be environmentally additional, verifiable, permanent, and enforceable.

Emission Allowance Allocations

An emission allowance allocation system should seek to mitigate economic transition costs to entities and regions of the country that will be relatively more adversely affected by GHG emission limits or have already made investments in higher cost, low-GHG technologies, while simultaneously encouraging the transition from older, higher-emitting technologies to newer, lower-emitting technologies. A significant portion of allowances should be initially distributed free to capped entities and to economic sectors particularly disadvantaged by the secondary price effects of a cap including the possibility of funding transition assistance to adversely affected workers and communities. Free allocations to the private sector should be phased out over a reasonable period of time.

Cost Control Measures

Cost control measures are policies designed to provide capped entities with greater confidence that their cost will be limited and flexibility to manage emission reduction compliance costs. We believe the most powerful cost control measure is a robust cap and trade program since markets do the best job of controlling costs over time. If used, cost control measures must be designed to enable a long-term price signal that is stable and high enough to drive investment in low- and zero-emitting technologies, including carbon capture and storage. Any additional cost-control option considered by Congress must ensure the integrity of the emissions cap over a multi-year period and preserve the market's effectiveness in driving reductions, investment, and innovation. As policy makers weigh additional cost control options, it is important for them to consider who and what portions of the economy are impacted, the time duration of the impact and remedy, international competitiveness, the implications for international emissions trading, and how the measure impacts the price signal necessary to stimulate investment and technological innovation. Some possible additional cost control options include but are not limited to a safety valve, borrowing, strategic allowance reserve, preferential allocations, dedicated funding, technology incentives and transition assistance.

Inventory and Registry

A national emissions baseline must be established. Legislation should establish a registry by no later than the end of 2008. The final regulations establishing a national registry and inventory of GHG emissions should ensure consistency in the definition, counting, and reporting of GHG emissions from all regulated entities (i.e., those that are subjected to the cap) and from all other emission sources on a voluntary basis. The U.S. inventory should include an estimate of all GHG emissions, not just those in the registry.

Credit for Early Action

It will take time to get a cap and trade program up and running. We need to reward those firms that have acted to reduce GHG emissions and encourage others to do so while the program is being established. Legislation should require regulations to be promulgated by no later than the end of 2008 establishing an early action program that grants a credit for reductions made starting from a specified date, such as 1995, until such time as the mandatory program becomes effective. Claimants would be required to demonstrate their eligibility for the credit based on accurate data.

We need to reward those firms that have acted to reduce GHG emissions and encourage others to do so while the program is being established.

Technology Policies and Measures

A federal technology research, development and demonstration (RD&D) and deployment program is a necessary complement to the GHG reduction policies that will drive demand for low-carbon technology. The program should be designed with the following key characteristics.

- Joint public/private sector cost-sharing and oversight;
- Establishment of performance criteria and a technology roadmap to guide RD&D and deployment program investment decisions;
- Stable, long-term financing (e.g., a dedicated federal revenue stream or other means not reliant upon annual congressional appropriations);
- Establishment of a public/private institution to govern the administration of the RD&D and deployment program fund; and
- A mix of deployment policies to create incentives to use low-GHG technologies and address regulatory or financial barriers. Such policies could include loan guarantees, investment tax credits, and procurement standards.

Sector-Specific Policies and Measures

Policies and measures are needed to complement an economically sound cap and trade system to create additional incentives to invest in low-GHG approaches in key sectors. The need and scope of sector specific policies and measures will depend on the stringency of targets, scope of coverage, and point of regulation in the cap and trade program. Some of the sector-specific policies and measures are intended to be transitional in nature and should be phased out over time. The following are suggestions for sector-specific policies and measures.

NEW COAL-BASED ENERGY FACILITIES AND OTHER STATIONARY SOURCES[1]

Coal supplies over fifty percent of our current electricity generation and will play a continuing role in our energy future. Policies are needed to speed transition to low- and zero emission stationary sources that can cost effectively capture CO2 emissions for geologic sequestration. We do not take a position as a group on any specific project, even though as individual organizations many USCAP Members do have such positions.

CARBON CAPTURE AND STORAGE

Congress should require the EPA to promulgate regulations promptly to permit long-term geologic sequestration of carbon dioxide from stationary sources. Congress should fund at least three sequestration demonstration projects in depleted and abandoned oil and gas fields and saline aquifers with CO_2 injection, each at levels equivalent to emissions produced by a large coal-based power plant.

[1] **The language contained in this section has been revised from the original version of this report to clarify the intent of the USCAP.**

TRANSPORTATION SOURCES

Climate protection legislation must achieve substantial GHG emission reductions from all major emitting sectors of the economy, including the transportation sector. We recommend Congress enact policies to reduce GHG emissions in the transportation sector, including consideration of policies to:

— Promote lower-carbon transportation fuels;

— Cost-effectively decrease allowable GHG emissions of automobile manufacturers' fleets and promote new low-emissions vehicles, for example with GHG or fuel economy performance standards;

— Efficiently decrease vehicle miles traveled and enhance mass transit and other less carbon-intensive transportation alternatives;

— Promote better growth planning;

— Educate consumers; and

— Address emissions from air, rail, and marine transport.

BUILDINGS AND ENERGY EFFICIENCY

Policies are needed to realize the full potential of energy efficiency as a high priority energy resource and a cost-effective means of reducing GHG emissions. To achieve this objective, climate legislation should establish federal and state policies that align financial and regulatory incentives with utilities' business interests to aggressively pursue energy efficiency programs and promote policies that "decouple" utility sales and revenues in conjunction with requirements for utilities to pursue all cost-effective energy efficiency savings. Stronger energy efficiency codes and standards are needed for whole buildings and for equipment and appliances, as are incentives and tax reform measures to advance the infrastructure necessary to support new "smart" and highly-efficient technologies and distributed generation. Finally, the legislation should create separate incentives for regulated entities, building owners, and other parties not subject to the cap to go even further in producing energy efficiency savings.

Policies are needed to realize the full potential of energy efficiency as a high priority energy resource and a cost-effective means of reducing GHG emissions.

International Engagement and Linkage

While taking the necessary first step of placing limits on our own emissions, Congress should strongly urge the Administration to safeguard U.S. interests by engaging in international negotiations with the aim of establishing commitments by all major emitting countries. The post-2012 global framework should establish international GHG markets, assist vulnerable populations in adapting to climate impacts, and boost support for climate-friendly technology in developing countries.

OUR COMMITMENT



We, the members of the U.S. Climate Action Partnership, pledge to work with the President, the Congress, and all other stakeholders to enact an environmentally effective, economically sustainable, and fair climate change program consistent with our principles at the earliest practicable date.

APPENDIX

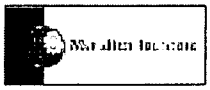
U.S. Climate Action Partnership Members

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Alcoa
American International Group, Inc. (AIG)
Boston Scientific Corporation
BP America Inc.
Caterpillar Inc.
ConocoPhillips
The Chrysler Group
Deere & Company
The Dow Chemical Company
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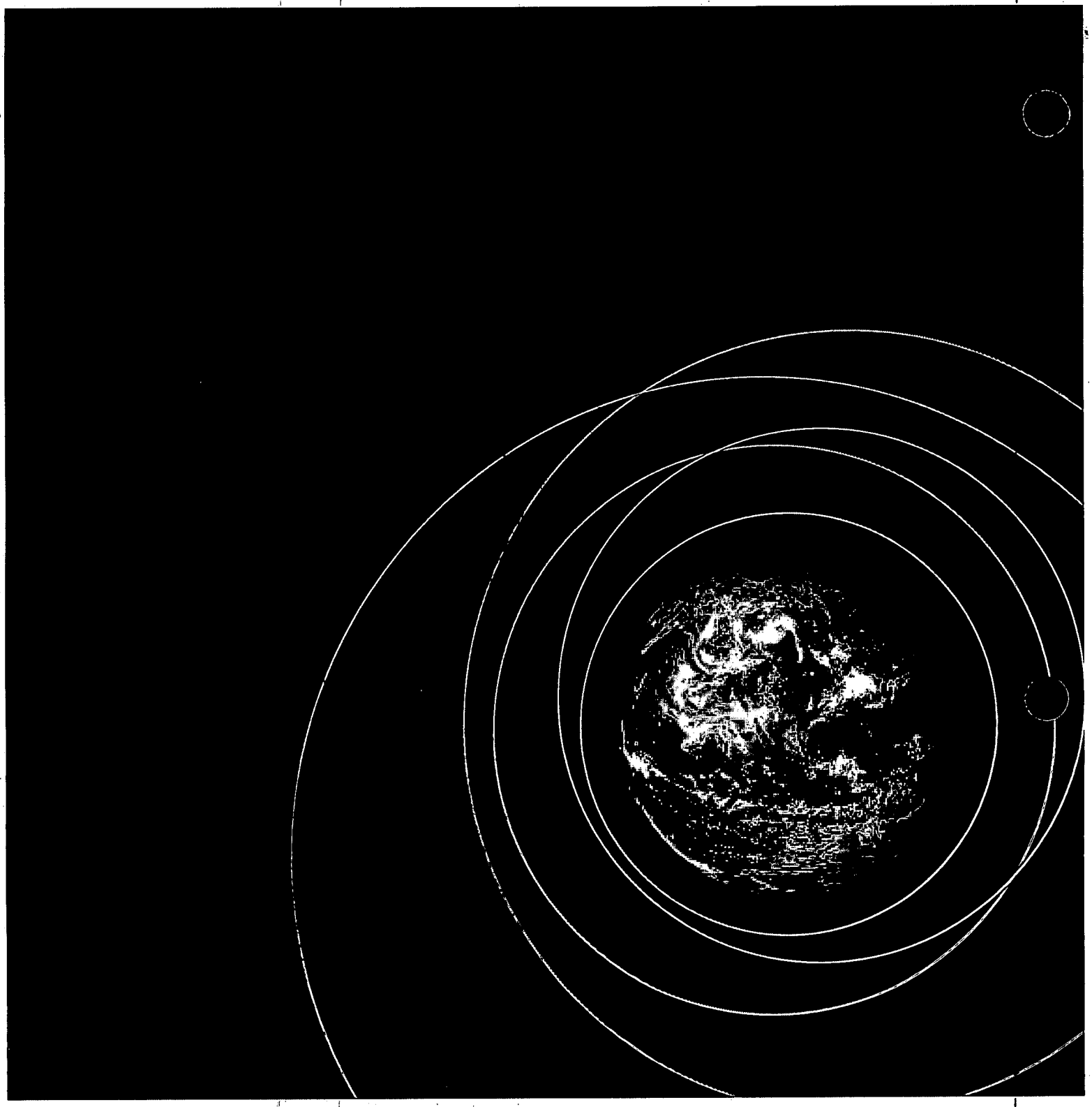
For more information about
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Washington, DC 20036
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Fax: 202-822-2156



The members of the USCAP wish to acknowledge the
valuable assistance provided by the Meridian Institute in guiding
and facilitating our discussions leading to this important agreement.



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NORTH CAROLINA CLIMATE PLAN -
DRAFT CONSOLIDATED CAPAG OPTIONS

ACTION PLAN AREA	COMPONENT ACTIONS	ESTIMATED OUTCOMES	IMPLEMENTATION NOTES
1. Heat and Power (Energy Supply and Demand in the Residential, Commercial, Industrial Sectors)			
a. Energy Efficiency & Conservation	• Demand-Side Management Programs for the Residential, Commercial and Industrial Sectors (RCI–1) • Expansion of Energy Efficiency Funds (RCI–2, ES-7) • Market Transformation and Technology Development Program (RCI–4) • Improved Appliance and Equipment Efficiency Standards (RCI–5)	• 23.5% of 2020 annual CAPAG reductions • -$24/ton GHG removed • $4.4 billion total NPV savings 2007-2020 • Energy savings: Approximately 34,000 GWh per year and 59,000 Billion Btu of natural gas per year by 2020	Legislative support is needed to offer incentives for investments—for example, through tax credits and/or loan guarantee programs--in energy efficiency and in customer-sited renewable energy, to support, and mandate where needed, updating appliance, equipment, and building energy codes, and to support aggressive and effective utility demand-side management programs.

ACTION PLAN AREA	COMPONENT ACTIONS	ESTIMATED OUTCOMES	IMPLEMENTATION NOTES
	• Building Energy Codes (RCI–6) • "Beyond Code" Building Design Incentives and Targets, Incorporating Local Building Materials and Advanced Construction, and Bulk Purchasing Programs for Energy Efficiency or Other Equipment (RCI–7) • Residential, Commercial, and Industrial Energy and Emissions Technical Assistance and Recommended Measure Implementation (RCI–11)		
b. Clean and Renewable Energy Supply	• Incentives for centralized renewables (ES-1) • Environmental performance standard; renewable energy generation target only (ES-2b) • Cap-and-trade; electric	• 20.4 % of 2020 annual CAPAG reductions • $19.5/ton GHG removed • $3,263 million total NPV cost 2007-2020 • Renewable energy: Approximately 20,709	Legislative support is needed to offer incentives to augment centralized renewable generation from utility/non-utility generators and procurement of greenpower; support for a transition in the way coal is used in NC for electric power production, and

ACTION PLAN AREA	COMPONENT ACTIONS	ESTIMATED OUTCOMES	IMPLEMENTATION NOTES
	sector only (ES-4a) • Aligning environmental and profit incentives (ES-5) • Integrated gasification combined cycle with/without carbon capture and storage - replacement of new 800 MW coal unit (ES-6a) • Waste to Energy (ES-8) • Green Power Purchasing (required for state facilities (RCI–9. ES-10) • Distributed Renewable and Clean Fossil Fuel Power Generation (RCI–10, ES-3, ES-9) • Expanded Use of Forest Biomass & Better Forest Management (AFW-9&10) • Ag Biomass Feedstocks for Electricity/Steam	GWh of incremental renewable generation by 2020	rules for a state-level cap-and-trade system.

ACTION PLAN AREA	COMPONENT ACTIONS	ESTIMATED OUTCOMES	IMPLEMENTATION NOTES
	Production (AFW-5)		
2. Transportation & Land Use (Energy Supply, Demand and Other Actions in the Transport Sector)			
a. Efficiency	Location efficiency • Land Development Planning (TLU-1a) • Surcharges to Raise Revenue (TLU-3a) • Rebates/ "Feebates" to Change Fleet Mix (TLU-3b) • Pay-As-You Drive Insurance (TLU-11) • Multi-Modal Transportation and Promotion (formerly TLU-2) (TLU-1b) Vehicle operations • Tailpipe GHG Standards	Location efficiency • 17.9% of 2020 CAPAG annual Reductions • Net savings/ton GHG removed • At least $3,100 million NPV savings 2007-2020 Vehicle operations improvements • 8.8% 2020 CAPAG annual Reductions • -$38/ton GHG removed • $-1,690 million NPV savings 2007-2020	Tax: "Surcharges to Raise Revenue" funds a substantial Transportation Demand Management program, which in turn produces important emissions reductions and infrastructure savings. The surcharge is small but important. Requirement: Local jurisdictions are required to plan. Outcome of planning is not set. Enforcement mechanism not identified. Requirement: Tailpipe GHG standards.

ACTION PLAN AREA	COMPONENT ACTIONS	ESTIMATED OUTCOMES	IMPLEMENTATION NOTES
	(California Clean Car) (TLU-5) • Idle Reduction, Elimination Policies (TLU-4, 8) • Truckstop Electrification (TLU-4) • Diesel Retrofits (TLU-9) • Advanced Technology Incentives (TLU-12)		
b. Clean & Renewable Fuels	• Biofuels Bundle (TLU-6, 7, 13) • Procure Efficient Fleets (TLU-7) • Buses – Clean Fuels (TLU-13) • Biodiesel Production (AFW-2) • Ethanol Production (AFW-6)	• 10.2% of 2020 annual CAPAG Reductions • $10/ton GHG removed.* • $486 million total NPV cost 2007-2020.* • Net Energy Savings: Assumed zero net energy, as energy created displaces energy saved. *Does not include TLU 6,7, 13.	Spending: Funding for state farmland preservation programs, Spending: Increase funding for Agricultural Development and Farmland Preservation Trust Fund. Requirement: Establish afforestation task force to advise NCDFR regarding enhanced FDP.
3. Farm & Forest Conservation			

ACTION PLAN AREA	COMPONENT ACTIONS	ESTIMATED OUTCOMES	IMPLEMENTATION NOTES
Land Protection & Conservation Practices	• AFW-4a (Preservation of Ag Lands) • AFW-4b (Preservation of Forested Lands) • AFW-8 (Afforestation and/or Restoration of Nonforested Lands) • AFW-13 (Urban Forestry) • AFW-3 (Soil Carbon Management, including organic production methods incentives)	• 9.7% of 2020 annual CAPAG Reductions • $2/ton GHG removed • $138 million total NPV cost 2007-2020 • Net Energy Savings: 34,274 billion BTU.* *Does not include AFW-3	Spending: Funding for state farmland preservation programs, Spending: Increase funding for Agricultural Development and Farmland Preservation Trust Fund. Requirement: Establish afforestation task force to advise NCDFR regarding enhanced FDP.
4. Waste Conservation			
Recovery & Recycling	• Increased Recycling Infrastructure and Collection (AFW-12) • Manure Digesters & Energy Utilization (AFW-1) • Landfill Methane & Biogas Energy Programs (AFW-11)	• 3.5% of 2020 CAPAG annual 2020 reductions • $9/ton GHG Removed • $274 million total NPV cost 2007-2020 • Energy Savings: 26,668 billion BTU	

ACTION PLAN AREA	COMPONENT ACTIONS	ESTIMATED OUTCOMES	IMPLEMENTATION NOTES
5. State & Local Government			
a. Information, Education & Outreach	• State Climate Public Education and Outreach (CC-4) • Education (Consumer, Primary/Secondary, Post-Secondary/ Specialist, College and University Programs) (RCI–8)	• Not quantified	CC-4: Additional staff and/or funding may be necessary depending on the extent of the public education and outreach effort. RCI-8: Legislative support needed to develop and provide consistent funding for education and professional training programs at all levels, as well as to set professional training requirements in key sectors.
b. Planning & Capacity Building	• GHG Inventories and Forecasts (CC-1) • State Greenhouse Gas Reporting (CC-2) • State Greenhouse Gas Registry (CC-3) • GHG Goals or Targets (CC-6)	• Not quantified	

ACTION PLAN AREA	COMPONENT ACTIONS	ESTIMATED OUTCOMES	IMPLEMENTATION NOTES
6. Adaptation			
Planning & Research	• State Climate Change Adaptation Strategy (CC-5)	• Not quantified	Funding to support development, analysis and implementation of the Plan.

North Carolina Legislative Commission on Global Climate Change

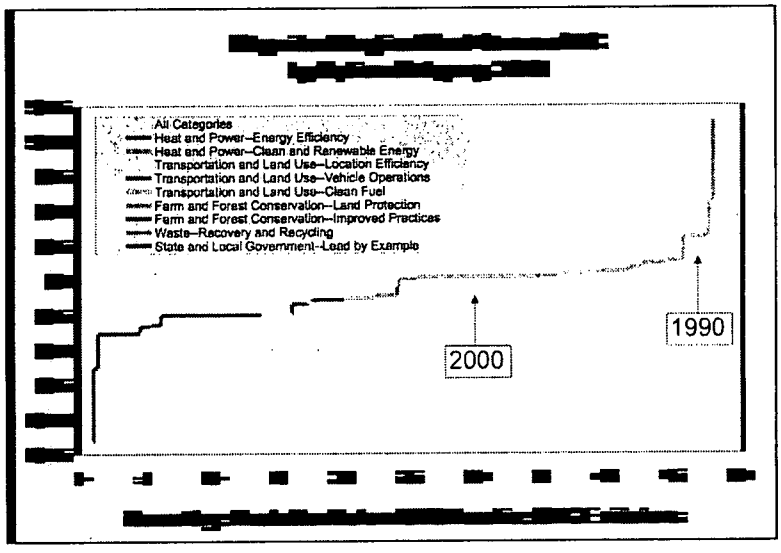
Draft Consolidated CAPAG Options

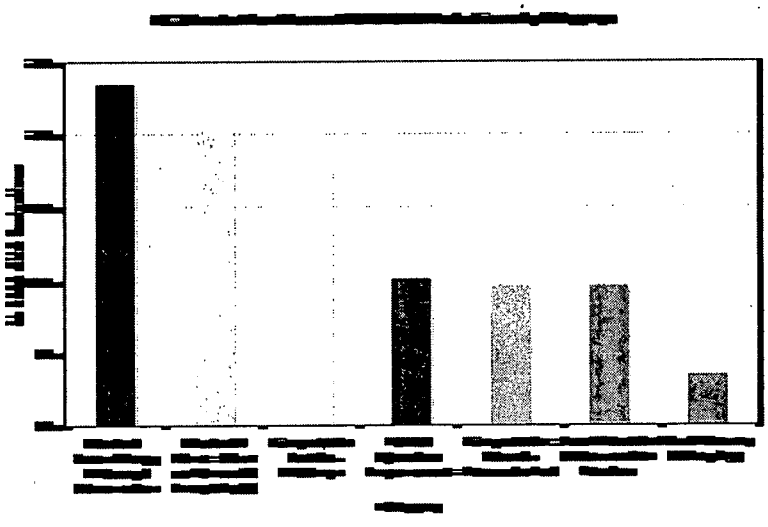
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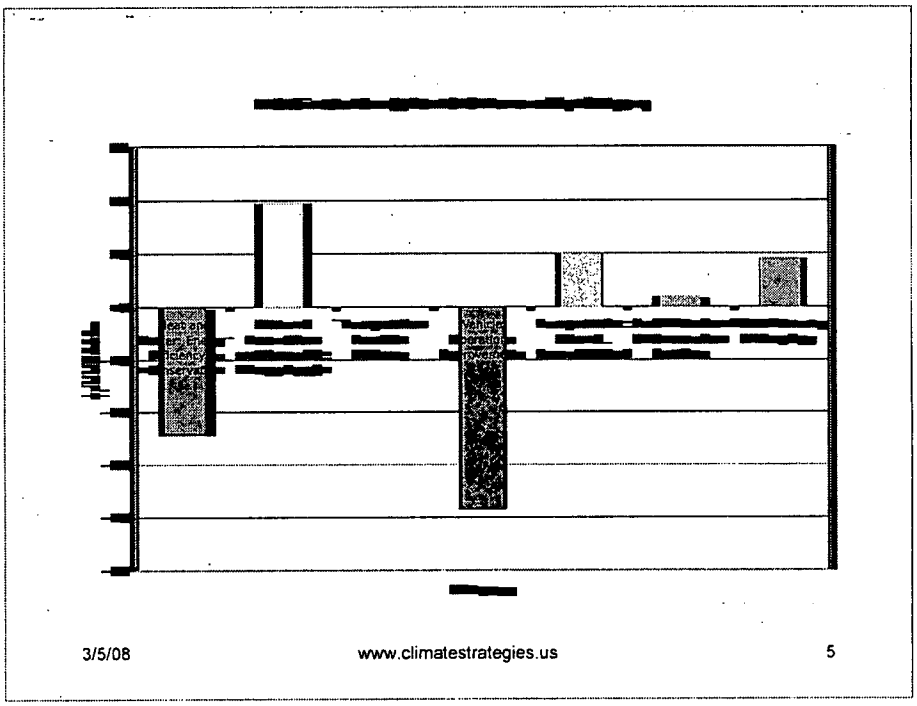
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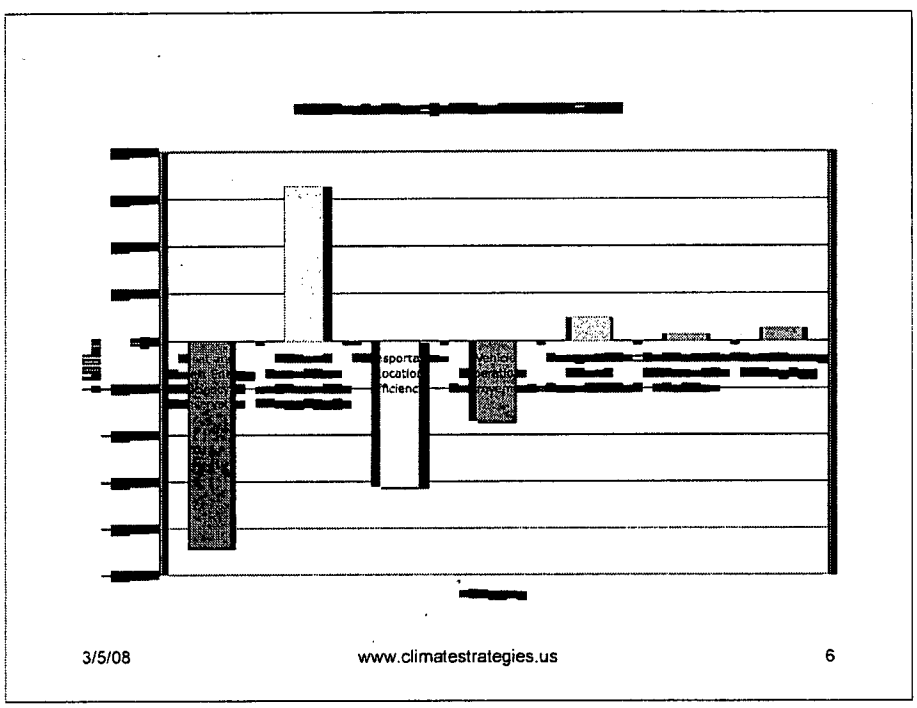
NC Climate Plan Categories

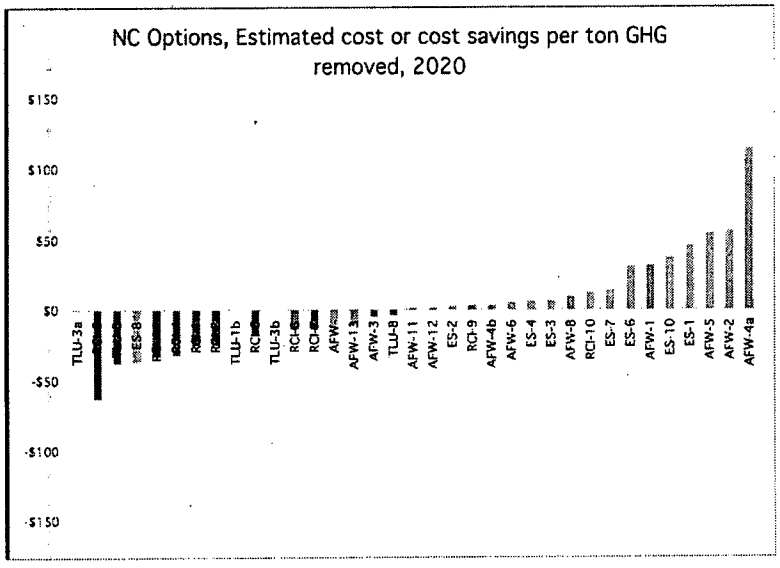
- Heat and Power
  - Energy efficiency and conservation
  - Clean and renewable energy
- Transportation and Land Use
  - Location efficiency
  - Vehicle operations
  - Clean and renewable fuels
- Land Protection and Conservation Practices
- Waste Recovery and Recycling
- State and Local Government
- Adaptation

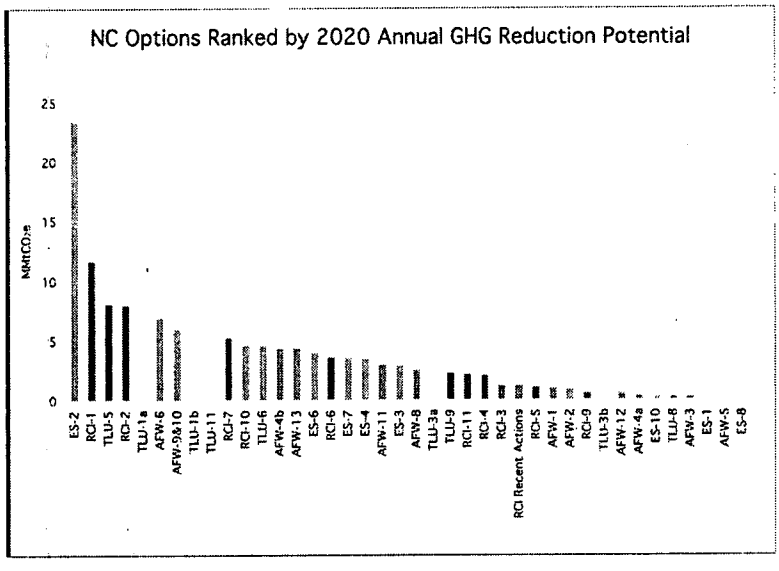

All Categories
Heat and Power--Energy Efficiency
Heat and Power--Clean and Renewable Energy
Transportation and Land Use--Location Efficiency
Transportation and Land Use--Vehicle Operations
Transportation and Land Use--Clean Fuel
Farm and Forest Conservation--Land Protection
Farm and Forest Conservation--Improved Practices
Waste--Recovery and Recycling
State and Local Government--Lead by Example
2000
1990

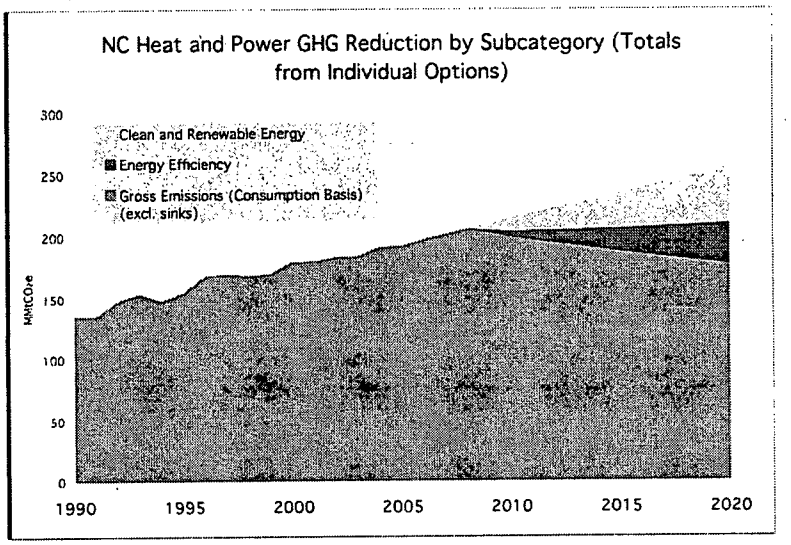


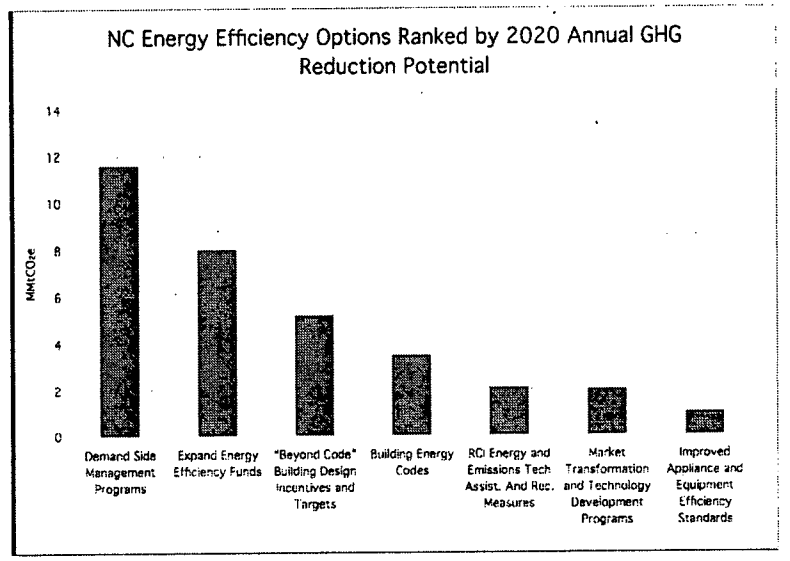


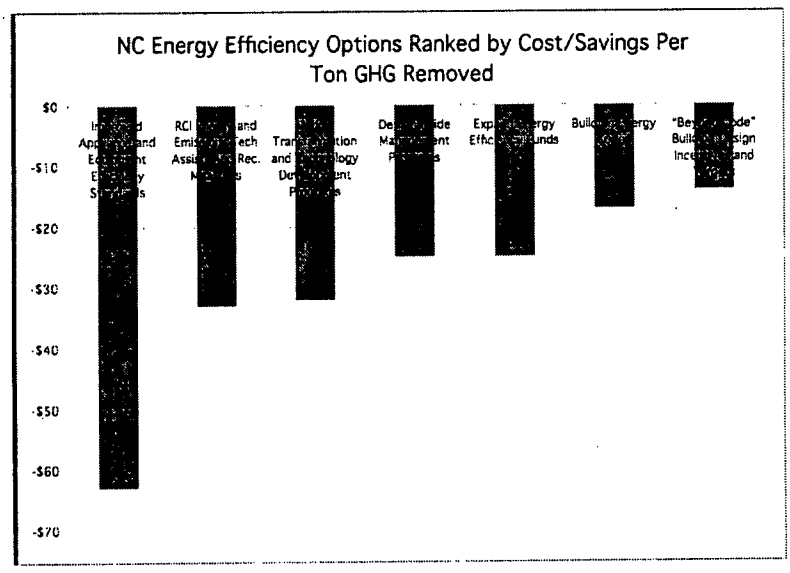


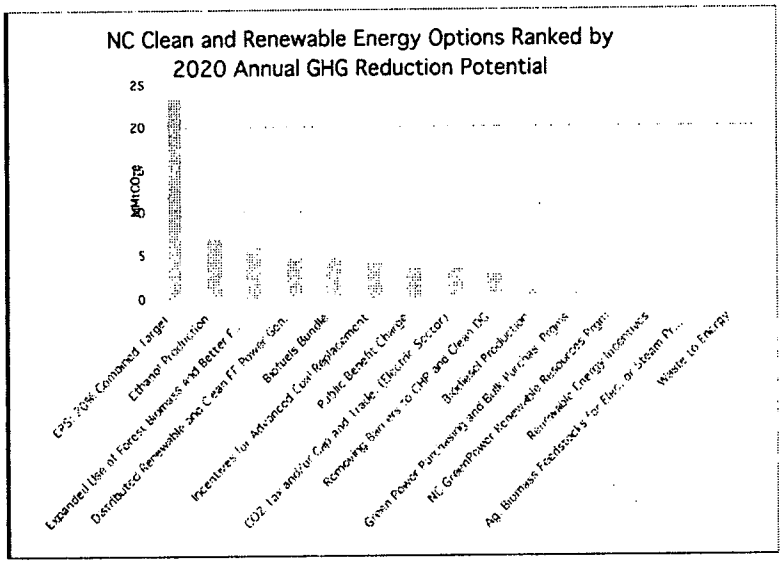

NC Options, Estimated cost or cost savings per ton GHG removed, 2020
$150
$100
$50
$0
-$50
-$100
-$150
TLU-3a
TLU-1b
TLU-3b
AFW-13a
AFW-3
TLU-8
AFW-11
AFW-12
ES-2
RCI-9
AFW-4b
AFW-6
ES-4
ES-3
AFW-8
RCI-10
ES-7
ES-6
AFW-1
ES-10
ES-1
AFW-5
AFW-2
AFW-4a

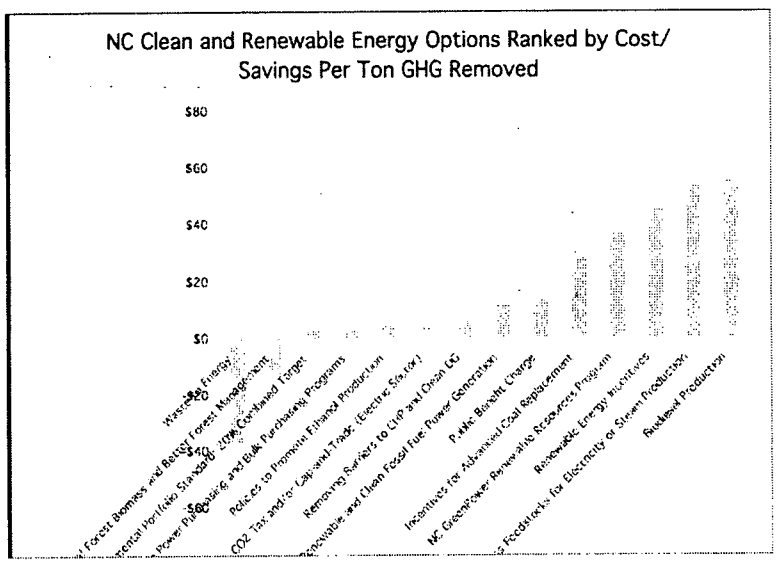

NC Options Ranked by 2020 Annual GHG Reduction Potential
MMtCO2e
25
20
15
10
5
0
ES-2
RCI-1
TLU-5
RCI-2
TLU-1a
AFW-6
AFW-9&10
TLU-1b
TLU-11
RCI-7
RCI-10
TLU-6
AFW-4b
AFW-13
ES-6
RCI-6
ES-7
ES-4
AFW-11
ES-3
AFW-8
TLU-3a
TLU-9
RCI-11
RCI-4
RCI-3
RCI Recent Actions
RCI-5
AFW-1
AFW-2
RCI-9
TLU-3b
AFW-12
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ES-10
TLU-8
AFW-3
ES-1
AFW-5
ES-8

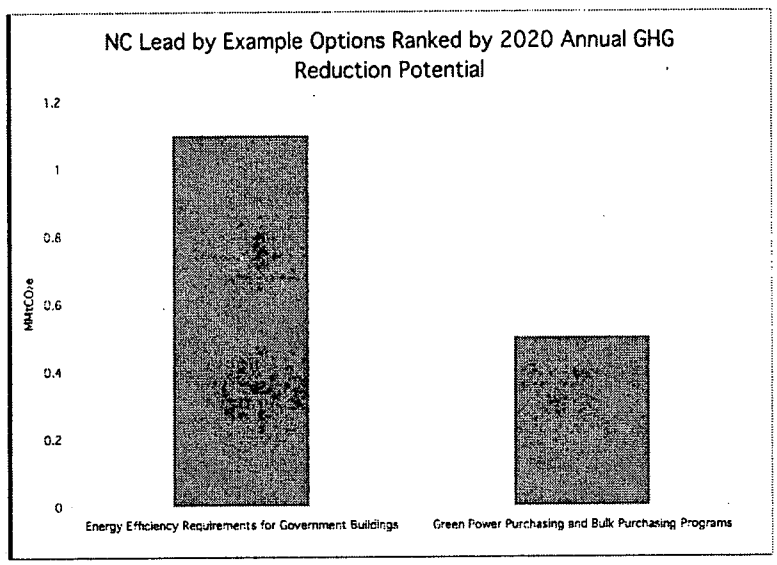

NC Heat and Power GHG Reduction by Subcategory (Totals from Individual Options)
Clean and Renewable Energy
Energy Efficiency
Gross Emissions (Consumption Basis) (excl. sinks)
MMtCO2e
300
250
200
150
100
50
0
1990
1995
2000
2005
2010
2015
2020

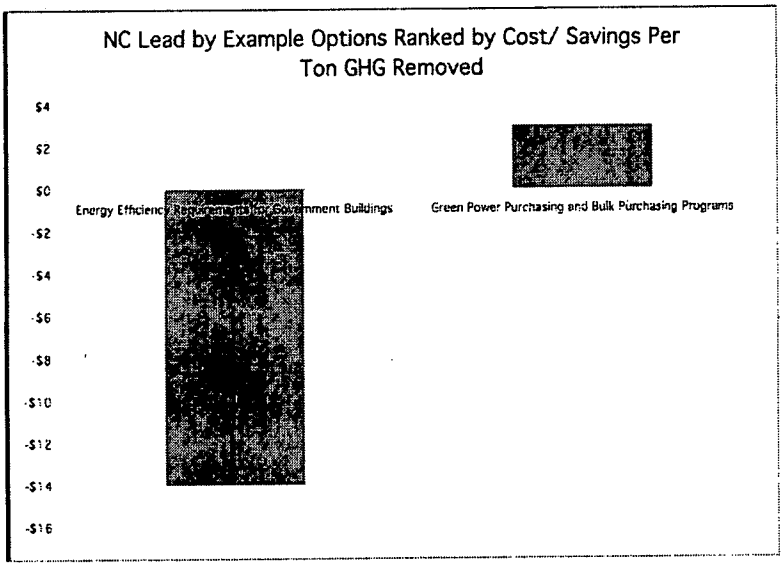

NC Energy Efficiency Options Ranked by 2020 Annual GHG Reduction Potential
MMtCO2e
14
12
10
8
6
4
2
0
Demand Side Management Programs
Expand Energy Efficiency Funds
"Beyond Code" Building Design Incentives and Targets
Building Energy Codes
RCI Energy and Emissions Tech Assist. And Rec. Measures
Market Transformation and Technology Development Programs
Improved Appliance and Equipment Efficiency Standards

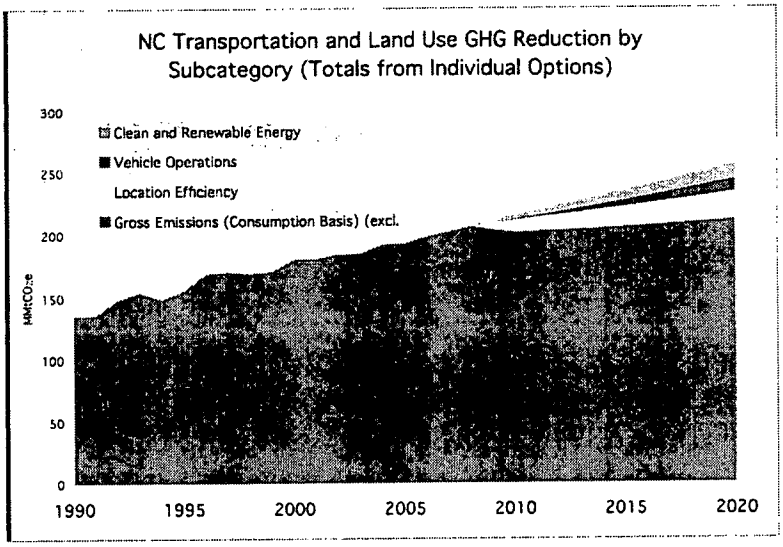

NC Energy Efficiency Options Ranked by Cost/Savings Per Ton GHG Removed
$0
-$10
-$20
-$30
-$40
-$50
-$60
-$70

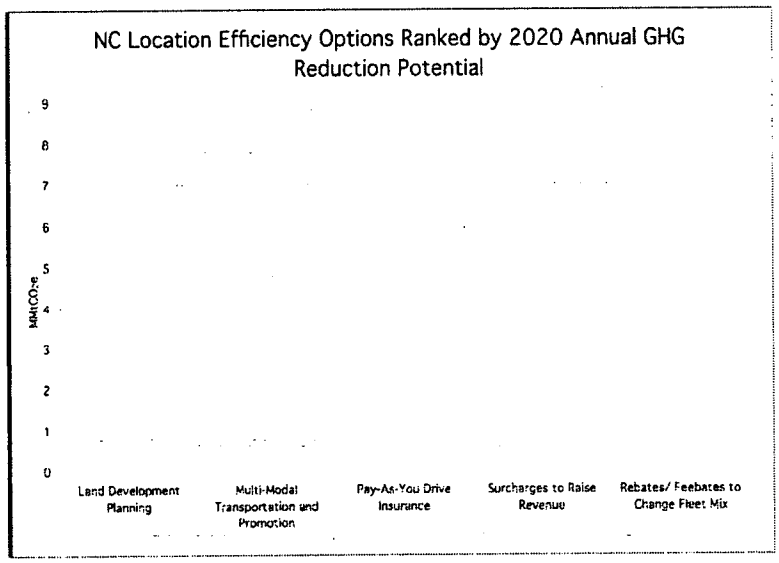

NC Clean and Renewable Energy Options Ranked by 2020 Annual GHG Reduction Potential
25
20
5
0
MMtCO2e
Ethanol Production
Biofuels Bundle
Public Benefit Charge
Biodiesel Production
Renewable Energy Incentives
Waste to Energy


NC Clean and Renewable Energy Options Ranked by Cost/ Savings Per Ton GHG Removed
$80
$60
$40
$20
$0
$(20)
$(40)
$(60)

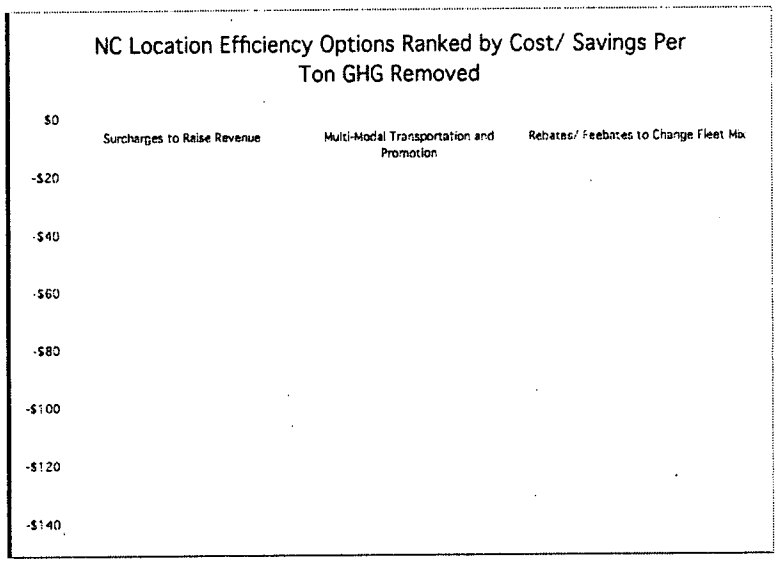

NC Lead by Example Options Ranked by 2020 Annual GHG Reduction Potential
1.2
1
0.8
0.6
0.4
0.2
0
MMtCO2e
Energy Efficiency Requirements for Government Buildings
Green Power Purchasing and Bulk Purchasing Programs


NC Lead by Example Options Ranked by Cost/ Savings Per Ton GHG Removed
$4
$2
$0
-$2
-$4
-$6
-$8
-$10
-$12
-$14
-$16
Green Power Purchasing and Bulk Purchasing Programs

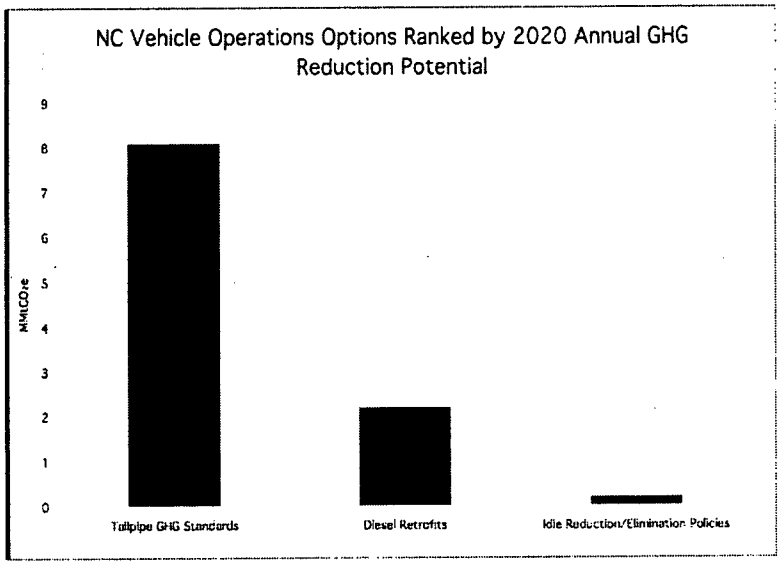

NC Transportation and Land Use GHG Reduction by Subcategory (Totals from Individual Options)
Clean and Renewable Energy
Vehicle Operations
Location Efficiency
Gross Emissions (Consumption Basis) (excl.
MMtCO2e
300
250
200
150
100
50
0
1990
1995
2000
2005
2010
2015
2020

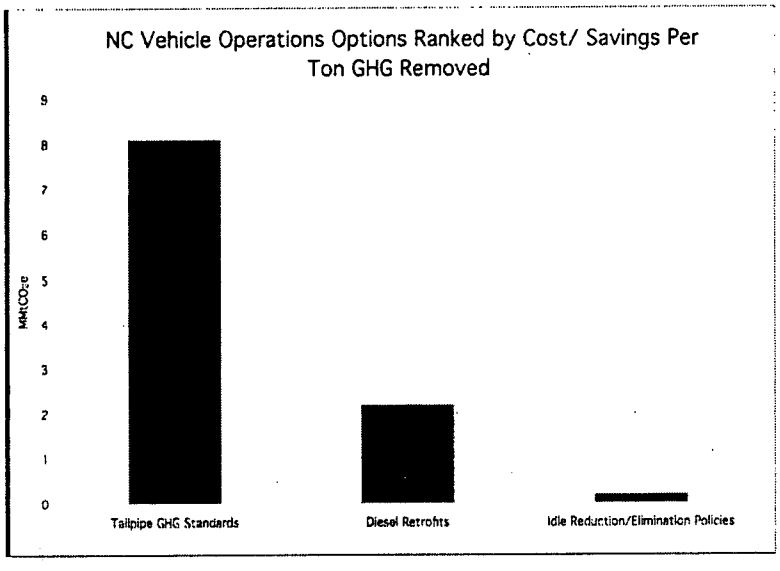


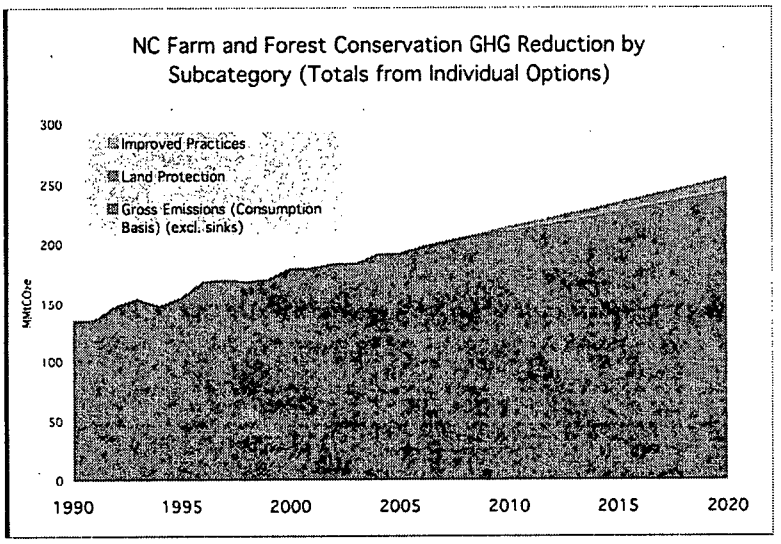
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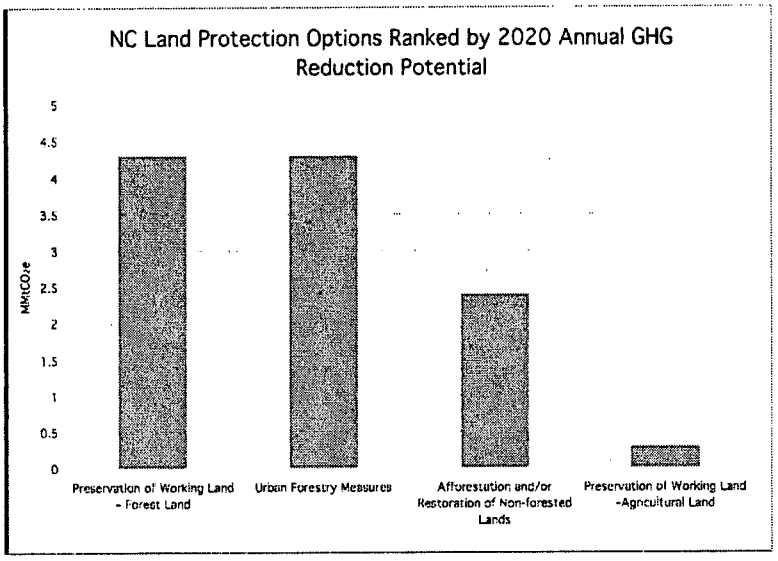
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NC Vehicle Operations Options Ranked by 2020 Annual GHG Reduction Potential
MMtCO2e
9
8
7
6
5
4
3
2
1
0
Tailpipe GHG Standards
Diesel Retrofits
Idle Reduction/Elimination Policies

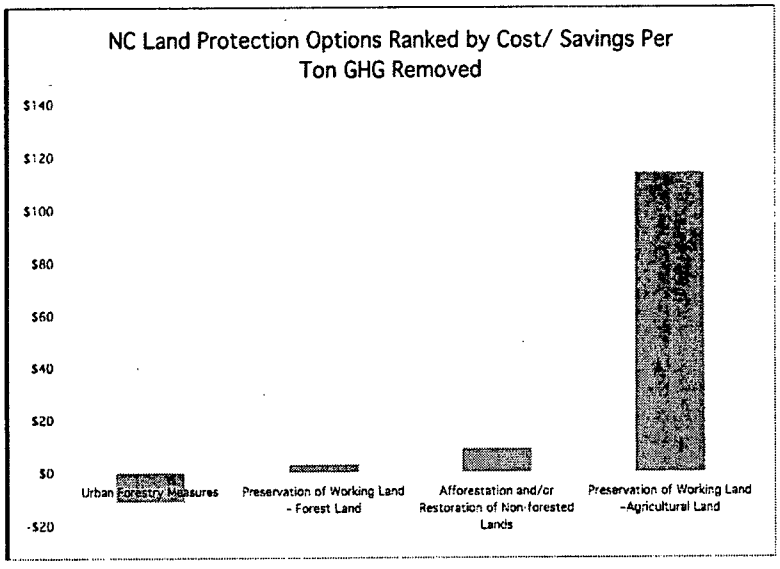

NC Vehicle Operations Options Ranked by Cost/ Savings Per Ton GHG Removed
MMtCO2e
9
8
7
6
5
4
3
2
1
0
Tailpipe GHG Standards
Diesel Retrofits
Idle Reduction/Elimination Policies



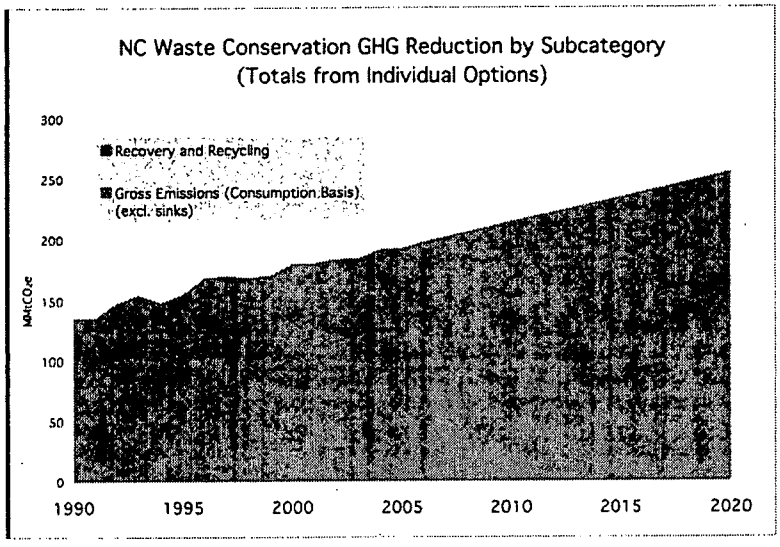
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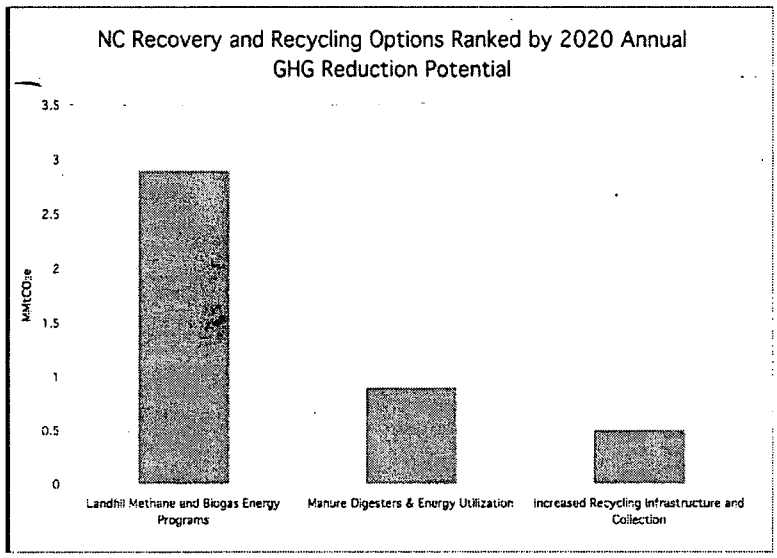
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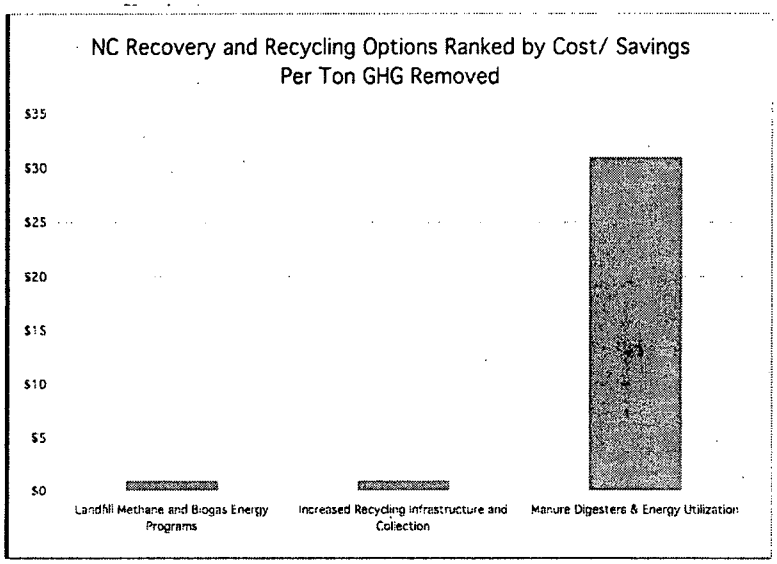
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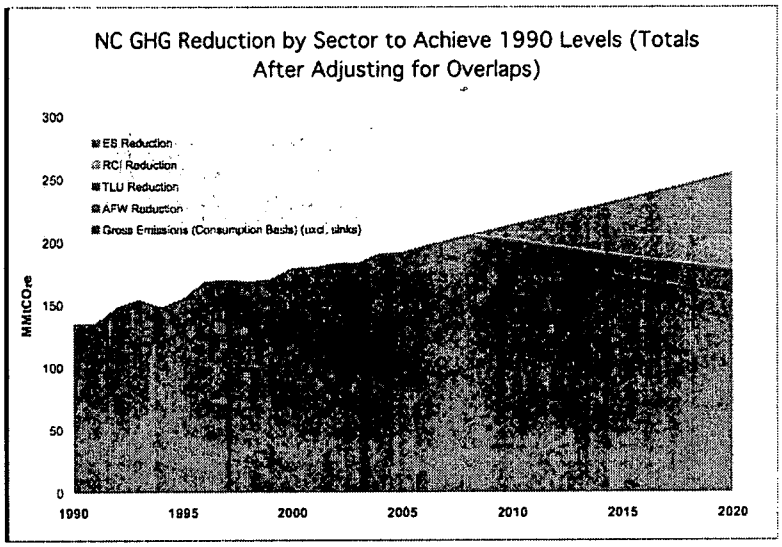
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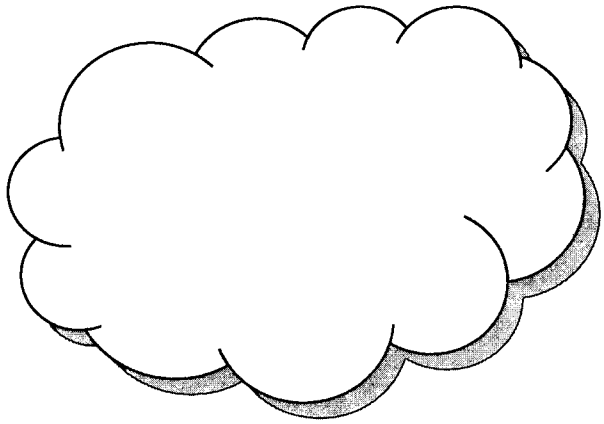


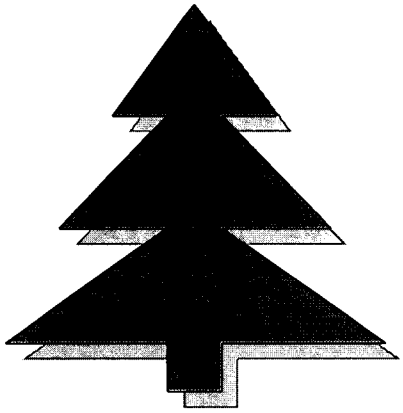
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NC GHG Reduction by Sector to Achieve 1990 Levels (Totals After Adjusting for Overlaps)
ES Reduction
RCI Reduction
TLU Reduction
AFW Reduction
Gross Emissions (Consumption Basis) (excl. sinks)
MMtCO2e
300
250
200
150
100
50
0
1990
1995
2000
2005
2010
2015
2020

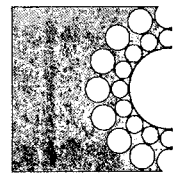






The North Carolina Green Cities Plan

Engaging the NC Legislative Commission On Global Climate Change



CENTERS FOR
Environmental and
Climatic Interaction

Executive Summary

*During recent years the Asheville community has devoted increasingly focused planning attention on climate issues, with the Asheville Hub Alliancerecently declaring climate change an economic development priority and assisting in forming an organization known asthe Centers for Environmental and Climatic Interaction (CECI) [a community based a 501(c)(3) corporation] to lead and support the effort. [**Appendix A** illustrates the relationships between CECI and its partners.]*

The potential for expanded growth of the National Climatic Data Center in Asheville, the mounting international science and concern regarding climate change,current and anticipated increases in federal climate-related funding and the growing demand for products and servicesrelated to adaptation and mitigation of global climate change create unprecedented opportunity for Asheville.

Consequently, the goal Asheville has set in this regard is to:

Establish a partnership with the State of North Carolina, the University of North Carolina, the Nicholas Institute for Environmental Solutions, national foundations and others to develop and establish a North Carolina Green Cities Plan to initiate, test and validate climate change management initiatives in urban climate environments, designate Asheville as the prototype site to test the Plan. [Appendix A.1 – schematic] and solidify Asheville's regional (if not national) leadership position in climate mitigation and adaptation.

A National Scientific and Market Resource in Asheville

> *"The Climate is no longer stationary, it is changing. Humans are facing a world unlike anything we have been accustomedto since the dawn of modern civilization. Regardless of our long-term actions we are already committed to major changes. A key question is how will we respond?"*
>
> Thomas R. Karl, Director
> National Climatic Data Center
> National Oceanic and Atmospheric Administration

Climate change is forcing new thinking in almost every dimension of life. Essentially every discipline will face changes in the way business is done, taking into account how climate adaptation and mitigation will impact planning and decision-making. In this context Asheville finds itself in a position to be an important hub for climate-related information, business development, sponsored research and project management.

Central to this opportunity is the fact that weather observation data from the United States and worldwide flows daily into the National Climatic Data Center (NCDC), a facility of the National Oceanic and Atmospheric Administration (NOAA), located in Asheville. Because of the rapidly emerging international concern regarding climate warming and its implications for every sector of national interest, this repository of data now spanning over six decades has taken on an unprecedented level of scientific and economic importance. In addition to the data, NCDC houses unique expertise on its staff, now boasting nine scientists who were

part of the Intergovernmental Panel on Climate Change process that was recently awarded the Nobel Peace Prize.

During the late 1990's, NCDC initiated the first scientific climate measuring instrumentation, known as the Climate Reference Network, dedicated specifically toward measuring climate change. This system of 250 pairs of specialized weather stations now located throughout the United States was initiated in Asheville in 2000 at The North Carolina Arboretum. NCDC also monitors satellite data, daily weather observations and other sources in managing and interpreting the national weather and climate patterns.

As the resources of NCDC become increasingly important to the national interest because of the urgency and significance of the climate change, as well as the international attention now focused on adaptation and mitigation to global warming, the Asheville community has initiated a number of actions to assume a leadership position and to leverage our resources with respect to climate change.

The State of Climate Change Nationally and Internationally

Every major news outlet on any particular day will likely carry a story related to the issue of climate change. The increasingly dire projections for global warming and the associated uncertainties they represent have captured the attention of the world. What once was a debate as to whether human activity is contributing to the problem has now moved to a search for trusted information, policies, products and services that can be targeted toward climate change adaptation and mitigation. Scientists worldwide are calling for rapid response from government and industry as a means of abating potentially dramatic impending consequences of warming.

In November 2007 NCDC hosted a NOAA-sponsored Users' Conference that brought to Asheville major corporate leaders in transportation, energy and reinsurance, as well as major figures in the science of climate change. The conference underscored the urgency and importance of these issues, but also brought to light the focused attention each of these industry sectors is giving to the future impacts of climate change. Whether building roads and bridges, managing ports, designing power generation facilities, or insuring such endeavors, these leaders underscored the need for trusted climate information at a local and regional scale relevant to their decision-making. Currently, most of the available climate modeling is at a more global scale.

The Climate Market

While the enormity and urgency of the climate problem is creating a global challenge, it also poses a major market opportunity for those with the ability to deploy assets toward the creation of products and services that are required to address adaptation and mitigation. Federal legislation and spending are now responding to the need for accurate measurement and monitoring, adaptation and mitigation research, and stimulation of private sector products and services. Corporate, civic and public demand for trusted climate information at the State and local scale is mounting, yet the modeling and computing challenges to provide this information are significant and specialized. Workforce development for this market will

entail both highly specialized post-graduate science and technology specialists with broad interdisciplinary perspective, as well as trained and retrained professionals and technicians in more applied settings.

It is expected that world-wide business related to climate change will grow dramatically during the next decade. Similar to the environmental regulatory and weather business sectors, the public expenditure of funds in the new climate change sector is expected to grow from $2-4 billion annually now to greater than $10 billion in the next five years. That investment will immediately further stimulate private business in this area from its infancy today to values exceeding $500 billion, creating a greatly expanded need for a uniquely trained workforce with skills in management and decision-making related to climate in all sectors of society. Asheville's CECI initiative is designed to attract a share of this new investment and business to Asheville and North Carolina. [**Appendix B** captures some of the anecdotal evidence related to market growth expectations.]

Why Asheville?

As early as the late 1990's when the global warming issue had begun to surface, area leaders in Asheville began to explore how our large expanses of public lands, diverse biodiversity, creative talent pool, specialized technology assets and regional institutions could contribute to addressing and interpreting the problem of climate change, as well as to leveraging these resources and the presence of NCDC into scientific and economic advantage.

What we have discovered is that the stars are aligned for Asheville if we work fast, identify our critical factors for success, understand and leverage our resident assets, acknowledge our relatively small size and limited resident research and graduate education capabilities, and catalyze key partnerships to build these weaknesses into competitive strengths. We must also gain fast familiarity with specifically how this market is developing, and position ourselves to create a climate-related economic cluster that can capture a share of this climate change market for North Carolina. This process has been aggressively under way for several years, and has now reached the point where our State and educational leadership must weigh in if we are to be successful. [**Appendix C and C.1** documents the Asheville organizations aligned behind this effort and the depth and breadth of green/sustainable initiatives that are already in place and under way in Asheville.]

The Compelling Economic Opportunity for Asheville

Multiple factors provide Asheville with an early but fragile advantage in the national "race" for leadership in climate change management and the resulting business and societal benefits that will accrue to the prevailing communities and organizations. These factors include an authentic and long heritage in weather and climate monitoring and the resulting data management, escalation of international concern over global climate change, local organizational alignment around climate issues and infrastructure, location in a natural regional laboratory and in a city advancing in its sustainable best practices, broadening affiliations with federal and non-governmental organizations, and anticipation of a concerted

national agenda addressing climate change adaptation and mitigation. [**Appendix D** chronicles the key actions that CECI and the Asheville community have undertaken to date.]

As a science and an industry, the climate change management market is in its infancy. It is anticipated that the coming years will see the emergence of new graduate programs incorporating broad disciplines in areas such as atmospheric science, climatology, meteorology, ecology, geography, marine science, business law, and related courses. It is also anticipated that the changing political leadership at the national level will be responsive to the emerging national and international climate debate and that new public investments in application research and commercial development will follow. As new forms of public and private commerce emerge that will be dependent on climate data and expertise, such as carbon credit trading and data information/interpretation tools, Asheville is in a position to vie for a leadership position as a significant node in what will be a national climate services network and bring federal programs and climate-related businesses to the region. More specifically, NOAA is launching a new generation of polar and geostationary satellites. This year the President has announced a new 74 million dollar initiative in the FY09 budget program for new climate sensors and related work to develop climate data records from these sensors. In FY07 NCDC has already received $3.2M in additional funding to begin preparatory work in this area. As a community, we need to take advantage of this growing responsibility at NCDC and help build upon this core climate monitoring work. NCDC is currently preparing itself to manage additional large Federal projects and programs of this type. Such projects and programs are often advanced through both academic and private sector grants and contracts. [**Appendix E** illustrates the Federal Business Model.]

These circumstances, the anticipated national priority that climate adaptation and mitigation research will receive, the need for trusted climate change information at the local and State level – all of which are very favorable to Asheville – have fostered the following climate-related target for Asheville:

Goal: **To establish a partnership with the State of North Carolina, the Nicholas Institute for Environmental Solutions, national foundations and others to develop a Green Cities Plan to initiate, test and validate climate change management initiatives in urban climate environments and have Asheville designated as the prototype site to test the Plan.**

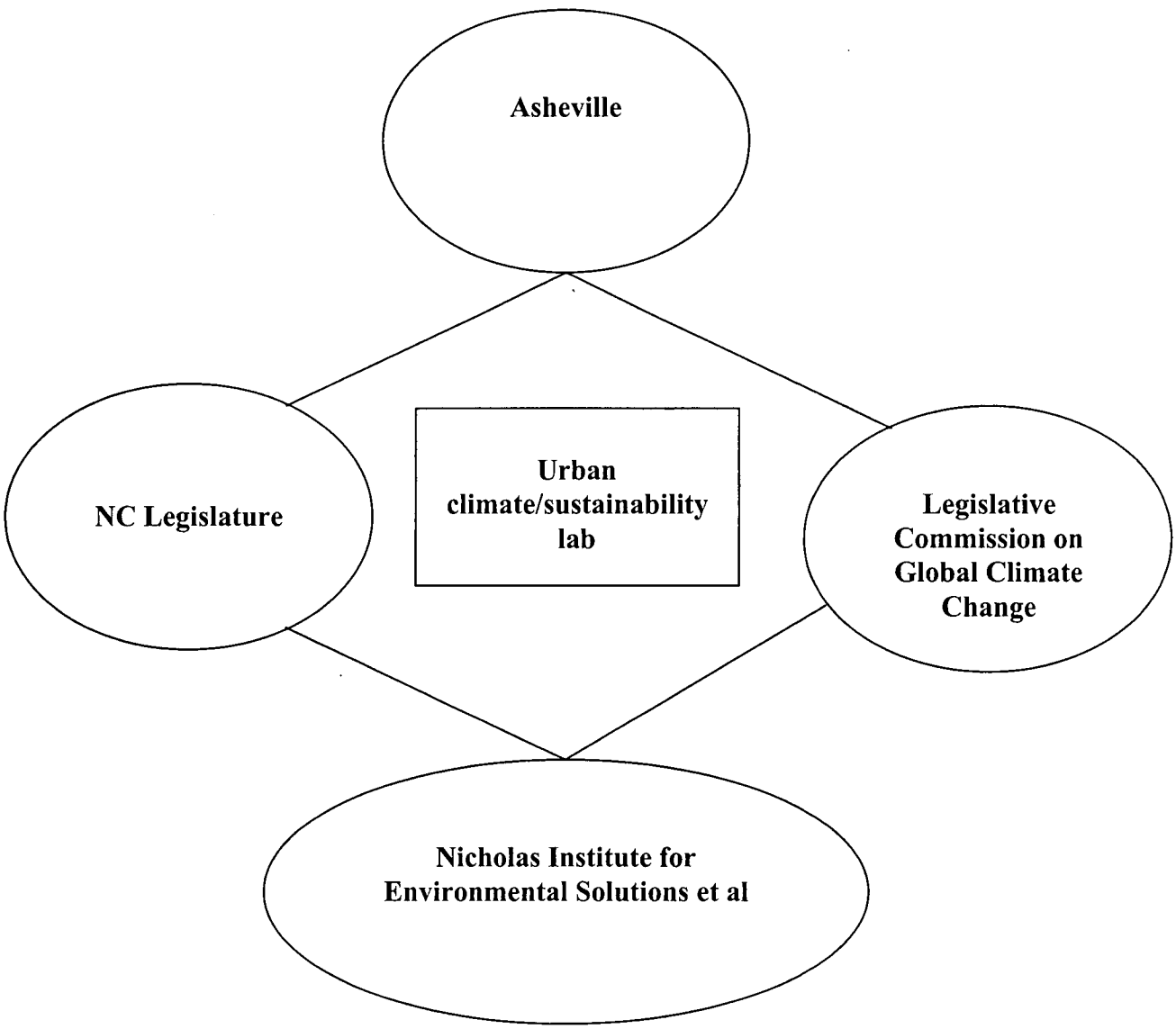
Strategy: **To recommend legislative action to: 1) establish a North Carolina Green Cities Plan [the "Plan"] to encourage all NC cities to initiate public and private green initiates focused on reduction in green house gas emissions and 2) fund the development of the Plan and the launch of an "urban green lab" near an established federal climate center to test and formally launch global climate change initiatives (see Appendix F).**

Appendix A

UNC / CECI Relationship Model

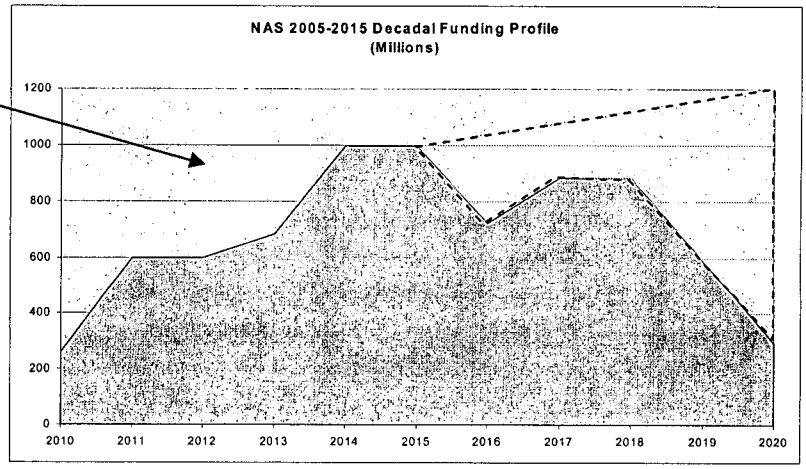
Appendix
A.1

NC Green Cities Plan



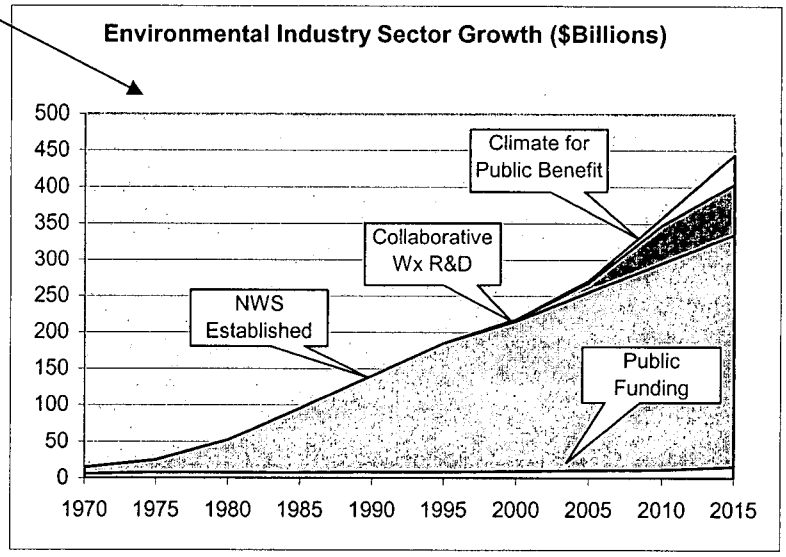
Appendix B

Evidence of Potential Growth in Federal Climate Programs and Commercial Demands for Related Products and Services



•NAS Decadal Study "Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond." ISBN: 0-309-66900-6

•"Report 2020 The US Environmental Industry & Global Markets, Environmental Business Journal, 2007.



• NSTC "Strategic Plan for the US Integrated Earth Observation System," Apr 2005 – No Numbers but Philosophic Agreement

•HR 906, Feb 7, 2007 establishes an operational program focused on adaptation and mitigation. "Global Change Research and Data Management Act 2007"

•"Final Report of the weather and Climate Team", Team Appointed by Gov Henry of Oklahoma to assess the impact of a collaborative research and development center at Norman, OK. Page 28. Demonstrates the concept even in a place that answers poorly in three critical aspects – commercial leader, lines of communications, and quality of life.

•Weather only affects 30% of the GNP; but climate affects 100% of GNP

•EOS Mission Profile: 1% Project Management, 31% Ground segment
Source: Program Manager for Mission to Planet Earth, Dr Greg Wilson
•House Appropriation Subcommittee Climate Plus Up "Above the President's Request" for 2008, $2.32B, NOAA, NASA, NSF, FS, USGS, PS, EPA To return EOS funding to peak status of approximately $2.1B.

Appendix C

Asheville Organizations Aligned to Address Climate Change Collaboratively

As early as the late 1990's when the global warming issue had begun to surface, area leaders in Asheville began to explore how our large expanses of public lands, diverse biodiversity, creative talent pool, specialized technology assets and regional institutions could contribute to addressing and interpreting the problem of climate change, as well as to leveraging these resources and the presence of NCDC into scientific and economic advantage. Various organizations in the area have organized around climate change as a priority area for regional scientific and economic development:

The Asheville Hub, an umbrella economic development organization, provides Asheville and other Buncombe County residents with a choice about the future of our community and the leadership to make the vision a reality. The Hub serves as a catalyst for collaboration around a coordinated, specific vision of what our economy and our community can become.

The Hub is pursuing high paying jobs in already-existing local economic sectors that are growing and will be very important in the future — examples include climate services and rejuvenation. The Hub also is focused on community and cultural development that will keep Asheville unique, dynamic and beautiful.

Centers for Environmental and Climatic Interaction, Inc. (CECI), begun as a working group of area leaders in 2005, serves as the leadership entity designed specifically to foster community climate-related initiatives and partnerships. Acting as an educational, research and advocacy organization, CECI represents the organizations and entities in Western North Carolina with climate interests. *Climate Alive!* (www.climatealive.org), a 7-minute video production, portrays Asheville and Buncombe County's unique resources that enable the area to aspire to become a national climate center.

The North Carolina Arboretum is establishing an early research capability in natural biotechnology and integrative medicine (Bent Creek Institute), has the interpretation and exhibit capabilities for touching large audiences, has a favorable physical location within vast Federal lands, pursues a mission specific to the "natural laboratory" of the Southern Appalachian region, and possesses an administrative structure conducive to broad partnership development among academic, governmental, and commercial partners. As such, it has been asked by the community to provide leadership for CECI.

Education & Research Services (ERS) is a 501(c)(3) non-profit organization that works with local officials, industry, state agencies and federal partners to bring education, research, and technology projects to the WNC region. ERS works to improve the business environment and expand educational opportunities in Western North Carolina. By developing public-private partnerships with government, private-sector, non-profit, and academic organizations, ERS builds regional capability to attract large projects and programs of national interest while enhancing regional economic development, technology and innovation. ERS has successfully built a strong relationship with Oak Ridge National Laboratory and UT-Battelle, bringing millions of dollars in education, research, economic development and technology commercialization funding to the region.

The Renaissance Computing Institute (RENCI) and National Environmental Modeling and Analysis Center (NEMAC) located at UNC-Asheville, have created unique capabilities for facilitating interpretation of data and decision-making using advanced visualization tools for use at the local and state levels. RENCI at UNC Asheville is an active collaboration between multiple community players, including NCDC, the US Forest Service, City of Asheville, Buncombe County, ERC Broadband, Media Arts Project, and many others. The collaboration uses a four-step business process: 1) Data integration, 2) Geospatial Visualization, 3) Science delivery through story telling, and 4) Creation of Decision Support tools. The team is addressing climate change related issues important to the State of NC, including flood mitigation, land use planning, and adaptation through scenario planning. Tools already created include a Decision Theater, Science Delivery in an Immersive Dome and numerous web tools and portals.

The WNC Applied Visualization Lab is a public/private/non-profit collaboration established to cultivate the momentum of environmental, digital media, information technology, and entrepreneurial resources in Western North Carolina. It is bringing together and leveraging advancements in the diverse and emerging fields of geographical information systems, data visualization, education technology, multimedia production, interactive computer graphics, and immersive display environments. By facilitating multi-disciplinary collaboration between entrepreneurs, scientists, engineers, media artists, educators, and policy makers, the Applied Visualization Lab is poised to become a leading supplier of effective visualization tools and techniques to address the world's most pressing economic and environmental challenges.

The Education and Research Consortium's (ERC) mission is to further economic development in the Western Carolinas through education, infrastructure and capital development. ERC Broadband is a locally operated, non-profit, state of the art, regional fiber-optic network providing high bandwidth opportunities and solutions to the educational, governmental, medical, non-profit, and economic development communities of the western Carolinas. This super-regional Internet backbone connects the educational and research community and offers local access as well as long haul transport with maximum reliability and uptime. The ERC Broadband has regional points of presence in Asheville, Brevard, Marshall, Burnsville, Waynesville, Cullowhee, Greenville, Spartanburg, and Charlotte.

The Media Arts Project cultivates innovative arts & technology in Western North Carolina. The MAP provides exhibition programming, professional development, outreach, and education. Media arts are integral to the vibrant cultural and economic life of the region, and an important ingredient in moving climate data into creative formats that are useful for information, education, and decision making.

Advantage West, Western North Carolina's Economic Development Commission, has established a commitment advancing the green building sector. Advantage West recently conducted a tour to Oak Ridge National Laboratory focused on these technologies and has introduced a new video production focusing on the regional opportunity in green building and alternative energy technologies.

UNC Institute for the Environment at UNC-Chapel Hill and the State Climate Office at NCSU will be important partners due to their working relationships with community interests.

Appendix
C.1

Why Asheville Should Be "The Green City" Prototype Site

The City of Asheville has taken the lead in making Asheville a party to the Mayor's Climate Protection Agreement

1. Asheville signed the Cool Cities Agreement in 2005 under Mayor Charles Worley
   - Protocol to reduce emissions caused by cities
     - Reduce energy use (buildings, vehicles)
     - Preserve green space
     - Clean up our air
     - Reduce traffic congestion
2. In 2006, Asheville joined ICLEI Cities for Climate Protection and initiated greenhouse gas inventory
3. In 2007, Asheville established SACEE (Sustainability Advisory Committee for Energy and the Environment), a city citizen committee to advise Council on sustainability issues
4. Asheville is the only city on the east coast to have Gold LEED standards for all new municipal construction projects
5. Hired a full-time energy coordinator in 2008 to create and institute an energy management plan
6. Asheville has set a 2% annual reduction in Green House Gas footprint from 2000 for a cumulative impact of 40% by 2040 from its 2001-02 baseline
7. Recycling and re-use program begun in 1997 24% in Asheville, 12.5 Buncombe, 4.2% statewide
8. The City of Asheville Water Resources Department is the first ISO 14001 registered water utility in North Carolina. ISO 14001 is a voluntary standard designed to help organizations address environmental issues.
9. Fleet Vehicles & Equipment Policy (2004)
   - Transportation Demand Management
   - Carpooling education/promotion
   - Better traffic controls management
   - Increased Bus Ridership by 24% with a free ride promotional program in 2006
   - Discount rates for bus riders
   - Community partnerships with local employers and schools to increase bus ridership
   - Mobile Source Emissions Grant awarded to construct Rapid fill CNG station
   - Key Partners: Mission Hospitals, Buncombe County, PSNC, Progress Energy
   - Public access to fuel ($1.30 per gallon)
   - 25 CNG vehicles (City/MSJ/Buncombe)
   - 8 GEM electric vehicles
   - 7 Ford Escape hybrids
   - 100 vehicles 'down-sized'

- **Active member of Clean Air Campaign**
- **Particulate matter traps on buses**
- **Low-sulfur diesel, E-85, bio-diesel used**

UNC Asheville – Tie to NEMAC and RENCI at UNC Asheville

1. **Presence of the RENCI with it VisWall and Geodome engagement site in Asheville**
2. **The presence of the NEMAC climate related Decision Theater, soon to be relocated from the A/B Tech Campus at Enka to downtown Asheville, for local and state decision makers which has been recognized by NOAA as an example of an NCDC product that should be rolled nationwide**
3. **With the NEMAC Decision Theater and related tools, the community will be able to clearly measure and display on the Asheville Green Wall pertinent information to determine if local climate mitigation initiatives are having an impact. The Green Wall will display a depiction of all the green initiatives being employed by the City and related metrics of progress**
4. **The importance of GIS (Geographic Information Systems) in the decision making process yields economic development opportunities. The current high level of expressed interest by ESRI [prime competitor to Google Earth] in the NEMAC decision support products.**
5. **RENCI at UNC Asheville collaborates with many local groups to form the Applied Visualization Lab to support economic development in this arena. The depth and breadth of Asheville's media arts applied visualization talent and companies, especially the total immersive dome technology product of the Elumenati company.**

National Climate Date Center

1. **The presence of the National Climatic Data Center [NCDC] in Asheville and the intimate engagement of NCDC with local decision makers and local and non-local institutions of higher education**
2. **The presence of 9 members on the IPCC [Intergovenrmental Panel on Climate Change] awarded the Nobel Prize and the intellectual capital they represent along with the total complement of 200 NCDC employees**
3. **The collaboration of the American Planning Association, UNC of Asheville and NOAA to create a Planning Handbook for Climate Change**
4. **Asheville hosted the NOAA climate data users conference in November of 2007 with a focus on climate change as it impacts re-insurers, power and transportation companies**
5. **The proximity of Oak Ridge National Lab and active interest in collaborating with NCDC in the area of climate change which will bring the highest possible super computing power to make climate data more granular**

6. **Positioned in a region with vast public lands of great biodiversity representing an important research opportunity regarding the impacts of climate change on regions with significant geographic and botanical diversity.**

CECI [Centers for Environmental and Climatic Interaction]

1. **CECI has been incorporated in 2008 to orchestrate all community resources – government, academic, business, NGO's – behind Asheville's substantial progress toward becoming a "Climate Center of the Nation."**
2. **CECI is in active negotiations with multiple parties in including the UNC System to create a multi-state, and multi-institutions of higher learning enterprise with a post graduate and post doc presence in Asheville that will bring a significant federal research work load to the area [see attached schematic]**
3. **CECI is serving as liaison to the pending arrival of a major private sector federal government research contractor to do climate related research in concert with NCDC and other national partners and companies**

The North Carolina Arboretum

1. **The North Carolina Arboretum is an affiliate institution of the UNC system and Western North Carolina's major state-supported attraction with 250,000 visitors annually.**
2. **The Arboretum serves as the administrative home and headquarters for CECI and provides a regional opportunity to interface climate change issues with noted and extensive regional assets of biodiversity.**
3. **The Arboretum's Executive Director serves as the President of CECI**
4. **Home of the Bent Creek Institute [the International Institute for Natural Biotechnology and Integrative Medicine] which is a research and economic development enterprise focusing on applications of advanced life science in building a vertically-integrated natural products economy.**
5. **Home of North America's only Medicinal Plant Germplasm Repository.**
6. **International reputation: Home of the World Botanic Gardens Congress in 2000 that published and adopted the "International Agenda for Conservation in Botanic Gardens, a conservational protocol now adopted by over 400 institutions worldwide.**
7. **Home of Western North Carolina's only green roof and the French Broad Training Center partnered with NCSU focusing on storm water management.**
8. **Significant institutional commitment to sustainability.**

Additional Reasons

1. **Proximity of Warren Wilson College, the nation's most sustainable higher education campus who, with the City of Asheville, have established the first campus and city partnership which is becoming a model for other communities**
2. **The presence of world class diverse biosphere and related regional R&D [US Forestry Service Laboratory]**
3. **The presence of extensive National Parks and Forests that offer virtual labs for analysis of the impact of global climate change**
4. **The presence of the Asheville Green Building Council**
5. **The presence of start up of a carbon offset company in WNC, Appalachian Offsets, a program of the Western North Carolina Green Building Council, is a voluntary carbon offset program to combat global climate change through local renewable energy and efficiency projects in Western North Carolina.**
6. **The growth of the biodiesel movement in Asheville, home of Blue Ridge Biofuels, a community owned business with the objective of bringing education and locally produced clean burning biodiesel to Asheville and Western North Carolina.**
7. **The presence in Asheville of a company that makes eating utensils out of potato starch v. plastic**
8. **The start up in Asheville of a new web based TV program – American Green TV [U TUBE environmental vignettes]**
9. **The current broadband communications capabilities distribute large volumes of data locally, regionally, and nationally. This data is collected and distributed by a community-focused, non-profit network. The Education and Research Consortium (ERC) continues to expand and have filed a request to extend the current WAN to the east to Black Mountain**
10. **The presence of Mathis Consulting, a leader in national building science, energy and sustainability: author of recent book Insulating Guide for Builders and Building Performance educators**
11. **Western NC Beekeepers in Buncombe County is the largest bee school in America (300 students in the last class)**
12. **The presence of ASAP (Appalachian Sustainable Agriculture Project) leader in the local food movement**
13. **The presence of the Slow Food Movement**
14. **Home of Earth Fare, the largest natural food chain in the SE**
15. **Home of Kleiworks, international community building and natural construction educators**
16. **Home to over 80 green builders (WNCGB)**
17. **Home of the first of its kind partnership between an Investor Owned Utility, Progress Energy, and the Community for Clean Energy Solutions**
18. **Home of Clean Water for North Carolina**
19. **Home of Sustainability Alliance of The Mountains coordinating sustainability networking of community organizations**

20. **SE headquarters for the Sustainability Institute [Drew Jones] that is doing sophisticated climate change modeling for companies like Nike and City Bank**
21. **Asheville's Evergreen School just won the 2nd most green school in the country contest with the Ellen Degeneres Show**
22. **The Biltmore House has instituted a wide range of sustainability initiatives**
23. **Asheville Public Housing is installing a solar water heater on its buildings with Appalachian Energy training residents to install solar units**
24. **Presence of Steve Cochran; Steve serves as Chairman of the Board of the Washington DC-based United States Partnership for Education for Sustainable Development, with more than three hundred multi-stakeholder and cross-sector partner organizations.**
25. **Support of Advantage West (Advantage Green) to cultivate the growth of green industries**
26. **LOSRC just received a $400,000 grant to promote EE and green energy in the region**
27. **Home to Seven Star Festivals:** Seven-Star is the world's premier green event planner, producer, and consultant and located in Asheville
28. **Conducted two Design Science Labs of the Buckeminster Fuller Institute were held in 2006. One Lab was conducted in New York City from June 21st through 30th at the United Nations headquarters and the United Nations International School with 55 participants ranging in age from 15 to 60. A second Lab was conducted from July 19th to 28th in Asheville, North Carolina with 35 participants ranging in age from 14 to 73.**
29. **Home of the Organicfest, one of the nation's largest regional organic foods festival.**
30. **Home to the organic Growers School, a result of the cooperation between representatives of North Carolina Cooperative Extension Service, North Carolina State University, Warren Wilson College, Blue Ridge Community College and many WNC farmers & educators**
31. **Home of the SEEE (Southern Energy Environment Expo) is an annual event designed to showcase renewable energy and sustainable economics in a context of responsible environmental stewardship**
32. **Home to Bountiful Cities Projects to create, on urban land, beautiful community spaces that produce food in abundance and foster a learning environment for social justice and sustainability working on seven [7] community gardens in Asheville**
33. **The existence of the Eco Agents, a real estate certification program that the Asheville Board of Realtors and the Clean Air Community Trust started in 2005. The Eco Agent Certification process is a 36-hour program that educates Realtors about a variety of green building development issues from indoor air quality to sustainable site design.**
34. **Home to the WNC Green Building Council, a 501C3 non-profit organization, whose mission is to promote environmentally sustainable and health conscious building practices through community education**

35. **Home to the Ashevillage Institute, an urban education center and living laboratory for sustainable solutions in action. They will be demonstrating natural building, permaculture, and organic gardening; offering community meeting space, workshops, presentations and a library**
36. **Home to the Asheville Communities Network Information and education on co-housing and other intentional community options in the Asheville area for those who are actively seeking or simply curious about alternate lifestyles for themselves and their families.**
37. **Home to Sustainable Now, a non-profit, prototype program to encourage and support sustainable living throughout the United States. Using Western North Carolina as its model region, the program combines live events, internet technology and broadcast media to reach the public.**
38. **Home to Sustainable WNC, which is sponsored by the nonprofit Mountain Area Information Network (MAIN), to serve as a web portal for businesses, nonprofits, citizens and local governments working to promote the principles and practices of sustainability in western North Carolina**
39. **Home to Asheville on Bikes, an advocacy group focused on advancing Asheville's urban bicycle culture. They are supporting the Bicycle Network Map project, the long range plan for Asheville's bicycle network created by the City's Transportation and Engineering Department with the support of members of Asheville's bicycling community**
40. **Home to Land-of-Sky Clean Vehicles Coalition, a multi-county, local government planning and development organization in NC. It is one of 17 such organizations in the state and serves Region B, which includes the counties of Buncombe, Henderson, Madison and Transylvania. Check out their webpage on regional transportation options**
41. **Home to The ReCyclery - a volunteer run nonprofit bike shop at 109 Roberts St. and Clingman Ave. Build a bike, learn how to fix bikes, or get your old one in working condition.**
42. **Location of Carbon Neutral Business Ad Campaign which is a loosely knit group of businesses, with leadership provided by Bend of Ivy Lodge and Appalachian Offsets, working to increase public awareness about the importance of carbon neutrality, and supporting environmentally responsible businesses. In the short term, ads donated at cost by local media will increase the visibility and public**
43. **Home to Southern Alliance for Clean Energy, a nonprofit organization that promotes responsible energy choices that solve global warming problems and ensure clean, safe and healthy communities throughout the Southeast with headquarters in Asheville.**
44. **Home to Sustainable Energy Council of WNC whose mission is to analyze, research and advocate for public policy that will result in energy efficiency, conservation and sustainable energy systems that are safe, sustainable and appropriate for human and environmental health while fostering equitable and socially responsible economic development.**

Appendix D

Key Actions to Date

The building of a climate change economic development plan began in earnest in early 2005 with the informal development of CECI and

Successful National Conference: NOAA Data User's Conference. In November 2007, NOAA's NCDC sponsored a national conference to enhance communication between the energy, transportation and reinsurance sectors of the U.S. economy and the National Climatic Data Center. Attended by over two-hundred leaders from government, academia and business, the conference helped to build an understanding of the need for accurate and clear information related to climate change. CECI hosted a dozen distinguished national leaders in climate-related commerce and research for dinner. Each affirmed the validity and need for CECI's vision.

Incorporation of CECI. The organization is now a registered non-profit corporation in NC and awaits approval of 501(c)(3) status from IRS. The initial board recruitment is complete.

Hub Strategy to Align Economic Development Efforts. The Asheville Hub has secured the services of a national consulting firm to assist the community in aligning its various economic development activities behind community priorities.

Development of Partnership with Oak Ridge National Laboratory. Leaders from NCDC, CECI, ERS, and SRC are in the process of developing a formal partnership among NCDC, ORNL, and NASA.

Oak Ridge Associated Universities (ORAU). Discussions regarding climate-related research projects are occurring with the leadership of ORAU, a consortium of 98 research universities, representing 38% of the nation's university research. ORAU advances science and education by partnering with national laboratories, government agencies, and private industry. A visit by the ORAU director to Asheville is planned. NC State, NC A&T, ECU, UNC-Charlotte, WCU and Duke are NC members of ORAU.

Visit from UNC-Chapel Hill Chancellor Moeser and his senior staff showcased the RENCI Engagement site in Asheville and the CECI partnerships that are in place.

Over the past five years, the Asheville community has developed a strong technical partnership with the climate-related science and engineering capabilities of NC State.

Nicholas Institute of the Environment at Duke University. A delegation from Asheville met with the Institute to discuss partnership interest – a follow-up meeting in Asheville is scheduled. Ray Clark, former Deputy Director of the White House Council for Environmental Quality and a fellow at the Institute organized the trip.

Scientific Research Corporation, a large advanced engineering company with 13 offices nationally, has made a commitment to open a climate division and an office in Asheville. A public announcement is pending.

Scheduled March visits from Scott Rayder, Chief of Staff to NOAA leader Lautenbacher and with former Gov. Jim Geringer (WY), spokesman for ESRI, Inc. and the GIS industry.

Appendix E

The Federal Business Model

Figure 1 shows a structure for CECI sponsored Federal activities. CECI provides the role of facilitator and advocate. Partnering centers will emerge that focus on business development in two distinct markets – 1. Federally funded collaborative research & development, and 2. Commercialization of the intellectual property generated by the R&D.

CECI as a 501.c.3 must remain above the specifics of business development efforts of the business centers. Its separation allows CECI to advocate the regional offering, the mission of NCDC, the composition and type of needed Federal R&D, and even the structure of the National climate change response without endangering the competitive stature of the collaboration business centers. This model, shown in Figure 1, is similar to that found in the Triangle where Research Triangle Park facilitates and advocates for new and expanded science-based work while Research Triangle Institute forms collaborative teams to compete for workloads or to develop new products and services.

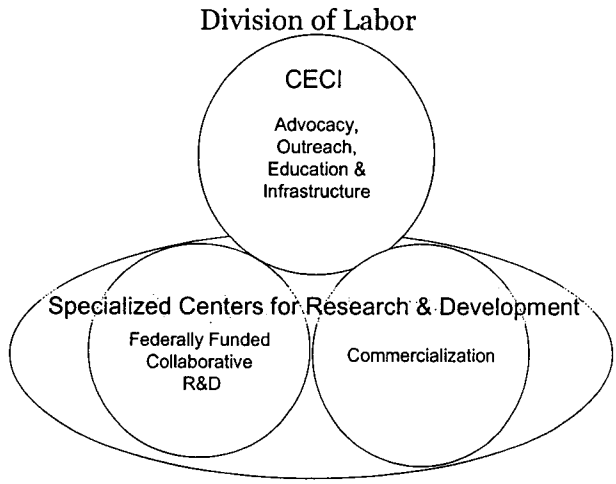


Figure 1. CECI Structure

Figure 2 depicts the distinction between the pursuit of Federal workloads and the development of new products and services. Federal work represents a single customer, and the companies that wish business there must spend time assisting, persuading, and externally influencing the definition of the workload in order to make the company's offerings competitive. This approach is much different from the standard business model that requires the analysis of the market, the competition, and strategic positioning of a company's assets to capture market share.

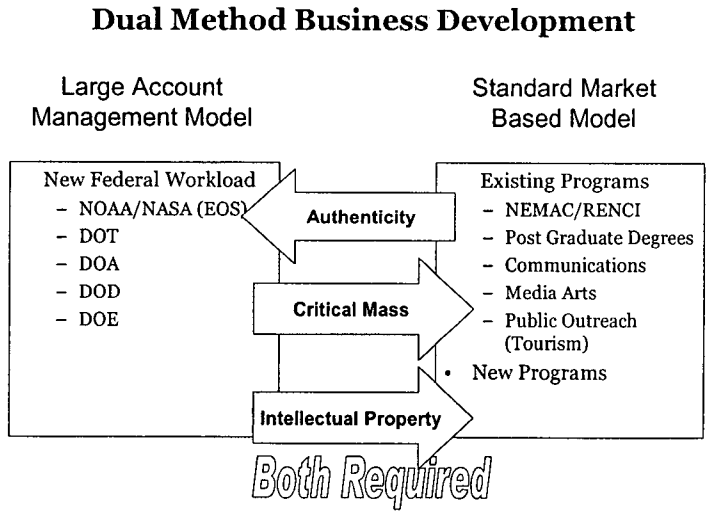


Figure 2. Federal Work vs. Standard Market Development

Appendix F

North Carolina Green Cities Plan

Objectives:

- **To seek a recommendation by the NC Legislative Commission on Global Climate Change of legislative action to establish a North Carolina Green Cities Plan [the "Plan"] to encourage all NC cities to initiate public and private green initiates focused on reduction in green house gas emissions.**

- **To seek appropriate funding for development of the Plan and funding for the launch of an "urban green lab" near an established federal climate center to test and formally launch mitigative/adaptive global climate change initiatives.**

- **To have Asheville designated as the North Carolina prototype city to pilot the Plan to test and validate the impact of green/sustainable initiatives on reduction of green house gas emissions on the urban climate.**

- **To seek designation from NOAA of Asheville as the first urban climate change lab in the US.**

Tactics:

- **To work with the NC Legislative Commission on Global Climate Change to draft appropriate legislation to initiate and seek funding for the Plan.**

- **To work with the interested partners (e.g., the University of North Carolina, Nicholas Institute of Environmental Solutions and national foundations) to develop detailed Plan components.**

- **In collaboration with Hub/CECI to develop documentation to support Asheville's request to be designated as the prototype test site for the Plan.**

- **To have Asheville/Buncombe's legislative delegation lead the effort to get the Plan legislation enacted and Plan funds appropriated.**

- **To establish a "green wall" in the proposed collaborative space sought by RENCI et al in the Asheville city center that would exhibit all that Asheville is doing and proposes to do to as the prototype test site for the Plan.**

Timing:

- **Immediately in order to seek enactment and funding in the short session in May of 2008.**

The Fit Factor

1. **The current buzz about Asheville as a national/international venue for climate change science, tools and services [see attached press releases on Asheville's readiness to serve in that role]**
2. **The existence of Asheville's progressive political climate**
3. **To be designated as the prototype green city test site in NC matches our practiced focus on sustainability [or mission, our cause our calling – it is who we are]**

asheville hub

As a Center for Climate Data and Decision Tools, Asheville Is Hot!

As people everywhere focus on climate change and what it means for our communities and our planet, Western North Carolina is a leader in climate data and decisionmaking tools. Asheville, NC, is home to the National Climatic Data Center (NCDC), the National Environmental Modeling and Analysis Center at the University of North Carolina Asheville, the Renaissance Computing Institute at UNC Asheville, the U.S. Forest Service's Southern Research Station, and the Air Force Combat Climatology Center.

Asheville's Climate Assets Are Key to Solving Global Problems

Scientists and entrepreneurs in our region are experts in environmental threat assessment, visualization, data management, high performance computing and new energy technologies. Asheville's hand is strengthened by:

- Access to the nation's high-resolution environmental databases and live satellite data feeds flowing into the NCDC. Because mining the massive databases takes immense amounts of bandwidth, it pays to be physically close to the archives.
- NCDC's interest in collaborating with those in Asheville who have complementary expertise. For example, NCDC and the former City of Asheville planning director are partnering to develop "Planning for Climate Change, a Handbook for City, Town and Rural Area Planners." University of North Carolina Asheville is a partner in the effort.
- A high-capacity fiber optic network providing advanced telecommunications infrastructure throughout Western North Carolina, made possible by ERC Broadband and a number of public/private partnerships. ERC also provides high performance computing and secure data storage (www.ercbroadband.org).
- A strong digital arts community that includes visualization experts experienced at working with climate data.
- Proximity to the Oak Ridge National Laboratory in Tennessee, which is developing technologies to help sustain the Earth's natural resources.
- Excellent educational institutions with respected programs in atmospheric, environmental and data sciences, and visualization.
- Our position in one of the world's most biodiverse regions and long history as a destination for health and healing. The Western Office of the North Carolina Biotechnology Center, the Bent Creek Institute, and the Mission Hospitals are partners in the research and discovery of medical treatments utilizing the matchless array of WNC's native species. Protecting these species is critical.
- The Technology Commercialization Center and other entrepreneurial support services, as well as a lively, growing community of knowledge-based technology companies.

In addition, *Climate Alive*, a future science and entertainment attraction that will teach the public about climatic and environmental interactions and public safety, is in the planning stages and will further Asheville's climate expertise and reputation.

National Climatic Data Center

The National Climatic Data Center (ncdc.noaa.gov) is a world leader in the climate community. Part of the National Oceanic and Atmospheric Administration, or NOAA, it holds the world's largest collection of

environmental data. NCDC provides the historical overview of weather for regions, offering vital clues about global warming, the effect of air quality and other climate-related developments. Its experts are the stewards of data that will enable society to deal with climate change and make sound decisions. With virtually every sector of the economy and the environment either directly or indirectly climate-sensitive, NCDC plays a critical global role.

NEMAC

Making sense of NCDC's data and turning it into decisions is the role of the National Environmental Modeling and Analysis Center (**orgs.unca.edu/nemac**). NEMAC addresses complex problems involving interrelationships of air, land, water, health and safety, and visualization is its specialty. The organization draws on Asheville's longstanding excellence in the arts and combines scientific data with digital art so policymakers can better comprehend problems and make effective decisions. NEMAC's many partners include NCDC, ERC Broadband, Education and Research Services, Inc., the U.S. Forest Service and Baron Advanced Meteorological Systems (www.**baronams.com**).

RENCI

A partnership between the University of North Carolina and Renaissance Computing Institute (**www.renci.org**), the initial project of RENCI at UNC Asheville is to turn massive amounts of data into visual 3-D weather models for disaster planning and response in Western North Carolina. When completed, the models will be used widely by government planners, emergency responders, educators and others to make effective decisions. The project combines GIS data and digital elevation models from Asheville and Buncombe County planners, the National Climatic Data Center's historic and real-time weather and climate data, and FEMA's historical flood data.

U.S. Forest Service

The Southern Research Station of the United States Forest Service (**www.srs.fs.usda.gov**) is the leading organization for research on natural resource management and sustainability in the southern United States. Its 130 scientists create the science and technology needed to sustain and enhance forest ecosystems and the benefits they provide.

Climate-Tested Workforce

Global information systems experts, meteorologists, air-quality technicians, botanists, mathematicians, statisticians, digital media specialists and talented professionals in other IT segments are key players in Asheville's growing science and technology community. UNC Asheville has outstanding undergraduate atmospheric science, multimedia and engineering programs. Offering North Carolina's first associate's degree in digital media, Asheville/Buncombe Technical Community College is training future digital media professionals who will turn raw radar data into information the public can understand and use.

For Climate Services Companies, the Outlook for Asheville is Sunny

For businesses and research organizations that rely on climate and other environmental data and whose employees desire a superior quality of life, Asheville is the ideal location. NCDC has the data and the experts to help private companies understand the information that is in its archives -- data that these companies can convert into commercial services at a time when decisionmakers around the world desperately need actionable information.

Asheville consistently tops Best Places to Live lists, and it has also been recognized by *Forbes* and others as one of the top metros for business, careers, and being an entrepreneur.

About the Asheville HUB

Through the Asheville HUB, a collaborative effort of public, educational and private organizations, Asheville and Buncombe County, NC, are pursuing specific strategies that will strengthen economic vitality in six clusters by building on the region's unique assets. The many organizations and individuals that make up the HUB's Technology Cluster are working to bring more government and private meteorological organizations to Western North Carolina, to establish a digital media center that will spur growth of the region's lively multimedia industry, and to fully realize the promise of the Technology Commercialization Center at A-B Tech.

For more information about the Asheville HUB, contact Dave Brown at brown@wfu.edu, or visit www.**ashevillehub.com**.

Revised 9/07

Asheville Is a Magnet for Knowledge-based Companies

Asheville is home to many innovative, talented and diverse companies that are creating a robust knowledge-based economy in the Blue Ridge Mountains. Software developers, digital media content developers, e-business experts and others are drawn here by the strong support structure for entrepreneurs, the region's advanced telecommunications capabilities, and the quality of life that has consistently put Asheville at the top of many Best Places to Live lists.

High-Capacity FiberOptic Network

A high-capacity fiber optic network that provides advanced telecommunications infrastructure throughout Western North Carolina is made possible by ERC Broadband (www.ercbroadband.org) and a number of public/private partnerships. ERC Broadband operates a resilient, fully protected OC48 SONET optical backbone within Western North Carolina with gateways in Washington, D.C., Atlanta, Charlotte and Raleigh/Durham.

ERC Broadband also provides high performance computing, secure data storage and retrieval, and disaster recovery services to government and commercial organizations. These agencies and companies find Asheville's medium size to be a big asset. They can move millions of bytes of information around the globe from here, but be safely away from a major metropolitan area where a natural or other type of disaster could occur. Even though Asheville isn't huge — which we think is a good thing — it's lively and exciting. The downtown business district, of course, is a Wi-Fi hot spot.

A City that Loves Its Entrepreneurs

Entrepreneurs account for a sizable chunk of Asheville's economy, and their big ideas and hard work are appreciated and supported.

Take the **Technology Commercialization Center** located within Asheville-Buncombe Technical Community College's Small Business Center Incubator. The center (www.abtech.edu/sbc/tcc) helps technology-based clients of the incubator develop an execution plan containing the company's technology development roadmap, market research, sales plan, capitalization plan, partnership and alliance analysis and financials required to prepare the company for sustainability or investment.

The **Blue Ridge Entrepreneurial Council** (www.brecnc.com) supports entrepreneurs through education, networking, communications and capital formation. BREC has helped local businesses raise capital, brought private equity investors to Western North Carolina to evaluate businesses, and recruited businesses with high-growth potential to the region. It hosts an annual venture capital conference.

Mountain BizWorks (www.mountainbizworks.org) helps entrepreneurs through financing, business instruction and on-going support. The organization assists close to 1,000 clients each year and offers loans up to $35,000.

Through the **Blue Ridge Angel Investors Network** (www.brainnc.com), entrepreneurs are able to work with an organized community of angel investors who want to invest in innovative companies with a presence in Western North Carolina.

IT-oriented entrepreneurs and professionals find like-minded folks through **Meet the Geeks**, a networking group dedicated to the growth and development of the IT sector in Western North Carolina. The Meet the Geeks web site (www.meetthegeeks.net) includes a directory.

Those specializing in digital arts find and collaborate with peers through the **Media Arts Project**

(www.themap.org), an initiative that cultivates innovative arts and technology in the region by providing outreach, professional development, education and exhibition programming.

Companies are Thriving Here

There's plenty of good company in Asheville. Take **BUILDERadius** (www.builderadius.com), a company that cuts red tape out of the building permit process by offering web-based services that make work easier for contractors, inspectors, city planning departments and others. Started in Asheville in 1999, the company has 30 employees today, half of them educated at local universities.

Baron Advanced Meteorological Systems (www.baronams.com) is expanding the frontiers of environmental computing. It implements air quality models, creates algorithms for parallel super-computers and develops visualization software.

HomeGauge (www.homegauge.com) is a locally grown company that transacts home inspections over the web and is the leader in its segment. Its software and services are being used across the United States and in a half dozen other countries.

EGlobal Design (eglobaldesign.com) moved to Asheville from Ft. Lauderdale several years ago and builds clients' brands online. Many of its clients are among the biggest names in the hospitality industry.

Netriplex (www.netriplex.com) provides managed hosting, utility computing, server co-location, disaster recovery and other managed e-business solutions for its clients worldwide. It recently chose Asheville as the location for its network operations and newest data center.

Many more knowledge-based companies are growing in Asheville and the surrounding area.

Talent on Tap

With many small knowledge-based companies here and area universities providing excellent training to students (many of whom want to stay in the area after they earn their degrees), plenty of talent on tap in Asheville.

The University of North Carolina Asheville (www.unca.edu), for example, offers engineering degrees in partnership with North Carolina State University, a multimedia arts and sciences program, and a computer science program. UNC Asheville is nationally ranked by *U.S. News & World Report, The Princeton Review* and others.

Asheville-Buncombe Technical Community College (www.abtech.edu) offers innovative career programs ranging from biotechnology to information systems security and web technologies. The recent addition of another school campus has allowed A-B Tech to create a small business incubator, the technology commercialization center, a corporate technology training and conference center, and a biotechnology incubation and training center.

Head to the Blue Ridge Mountains

For knowledge-based professionals who desire both a collaborative environment that creates sparks and a superior quality of life, Asheville is a very cool place to be. It's a place where you can be creative and productive while you are working, and then instead of wasting valuable time commuting to and from work, you can spend your free hours on a bike, in a kayak or on a hiking trail. The arts, music, recreation and many other aspects of daily life here are as good as it gets.

About the Asheville HUB

Through the Asheville HUB, a collaborative effort of public, educational and private organizations, Asheville and Buncombe County, NC, are pursuing strategies that will strengthen economic vitality in six clusters by building on the region's unique assets. The many organizations and individuals that make up the HUB's Technology Cluster are working to establish a digital media center, to bring more government and private meteorological organizations to Western North Carolina, and to fully realize the tremendous promise of the Technology Commercialization Center at A-B Tech. For more information, please contact Dave Brown at brown@wfu.edu, or visit www.ashevillehub.com.

Revised 9/07

As a Digital Arts Center, Asheville Is Cool!

The Asheville area has a long history of innovation in the arts, dating back to the Bauhaus movement and the innovations of Black Mountain College. Over the past decade, visualization wizards, graphic and interactive designers, film producers, animators, performance artists, game developers and others who apply technology to convey concepts, knowledge or stories have been streaming to Asheville. They are putting their skills to work in advertising, scientific visualization, education, software development, computer art and other exciting endeavors, drawn by the talent they see here, the refreshing and energizing level of collaboration, and everything that makes Asheville, well — Asheville.

Counting Asheville's Assets Requires Most of Your Digits

Digital artists are making Asheville and the surrounding area a truly happening place. Many assets beckon them here:

- The Media Arts Project (www.themap.org) is an initiative that gathers and showcases digital artists in the region. The MAP has sparked phenomenal collaboration within Asheville's media arts community, and it has formed a bridge for artists to connect with the region's science, education and business communities.
- The Applied Visualization Lab is a collaboration between public and private interests to bring together and leverage advancements in geographical information systems, data visualization, education technology, multimedia production, interactive computer graphics and immersive display environments.
- Asheville has significant climate data assets, and the combination of climate and digital arts expertise is creating powerful decision tools. The Applied Visualization Lab recently demonstrated its expertise on a global stage at the 5th International Symposium on Digital Earth. Inside a portable geodome visualization environment, world leaders from the business, academic and government sectors experienced a unique animation of the effect of weather, development and land use through the story of how a storm moves through Western North Carolina.
- The Multimedia Arts and Sciences program at UNC Asheville (www.mmas.unca.edu) is grooming gifted digital artists, and Asheville-Buncombe Technical Community College (www.abtech.edu) offers North Carolina's first associate degree program in digital media.
- A high-capacity fiber optic network that provides advanced telecommunications infrastructure throughout the region is made possible by ERC Broadband (www.ercbroadband.org) and a number of public/private partnerships.
- A trained and talented digital media workforce is in place and highly motivated to work and play in Asheville.
- Meet the Geeks, a group dedicated to the growth and development of the IT sector in the region, provides support.

The MAP

The Media Arts Project is an organization of artists, professionals, students and enthusiasts that has done a great deal to organize and harness the momentum around media arts in and around Asheville. The MAP cultivates innovative arts and technology, providing outreach, professional development, education and exhibition programming. It administers a grant fund for media artists working in or based out of Western North Carolina, and it also serves as a beacon and guide for newcomers on the Asheville media arts scene.

Applied Visualization Lab

Digital artists working with visualization tools can make the invisible visible. At the Applied Visualization Lab, the plan is to convert mountains of data from diverse databases into pictures that help policymakers make scientifically informed decisions about planning and development, adaption to climate change and a host of other issues. By facilitating collaboration between scientists, engineers, media artists, entrepreneurs and policy makers, the Applied Visualization Lab will create effective visualization tools and techniques to address the world's most pressing economic and environmental challenges.

One of the lab's partners, the Renaissance Computing Institute (RENCI) at UNC Asheville is focused on developing tools for environmentally-oriented disaster planning and response in Western North Carolina. By cultivating the resources of all of its partners, the Lab will enable the region to become a primary supplier of products that will enable communities worldwide to use visualization to solve problems and adapt to change.

The vision for the Applied Visualization Lab has been the driving force behind the Applied Visualization Symposium, now in its fourth year and attracting a national audience of scientists and artists.

Asheville Hosts Unusual Creative Festival

In Spring 2009, Asheville will be home to Asheville HATCHfest, a new annual festival that showcases some of the world best creative artists in film, fashion, music, architecture, design, multimedia, writing, journlism and photography. These top professionals will come to Asheville to mentor up-and-comers in each of the disciplines. Stay tuned for details!

Hatching New Digital Artists at the Area's Institutes of Higher Learning

Multimedia Arts and Sciences students at UNC Asheville are creating impressive works in 2D animation, 3D animation, stop motion animation, digital imaging and prints, interactive and web applications, and video and audio. The program's home within a highly regarded liberal arts institution helps make it special. In addition to acquiring technology skills, students learn how to think, be creative, express themselves and become well-rounded citizens as well as wonderful digital artists.

Offering North Carolina's first associate's degree in digital media, Asheville/Buncombe Technical Community College (A-B Tech) is training future digital media technicians who will turn data into information the public can understand and use.

Preview of Coming Attractions — A Digital Media Center Is in the Works

Now Asheville is working to create a state-of-the-art facility that will send media arts and technologies from the southeastern United States onto the international stage. The planned digital media center will serve as a catalyst that stimulates cutting edge research and experimentation and fosters collaboration between private, public and educational interests.

Head to the Mountains

For digital artists who desire both a collaborative environment that creates sparks and a superior quality of life, Asheville is a very cool place to be. Asheville consistently tops many Best Places to Live lists, and it has also been recognized by *Forbes* and others as one of the top metros for business, careers, and being an entrepreneur. Creativity and technology are having a fine time together in Asheville, and you don't want to miss the fun and the challenge.

About the Asheville HUB

Through the Asheville HUB, a collaborative effort of public, educational and private organizations, Asheville and Buncombe County, NC, are pursuing specific strategies that will strengthen economic vitality in six clusters by building on the region's unique assets. The many organizations and individuals that make up the Asheville HUB's Technology Cluster are working to establish the aforementioned digital media center, to bring more government and private meteorological organizations to Western North Carolina, and to fully realize the tremendous promise of the Technology Commercialization Center at A-B-Tech.

For more information about the Asheville HUB, contact Dave Brown at brown@wfu.edu, or visit www.ashevillehub.com.

As a Center for Climate Services, Asheville Is Hot!

CENTERS FOR
Environmental and
Climatic Interaction

As people everywhere focus on climate change and what it means for our communities and our planet, Asheville's Centers for Environmental and Climatic Interaction (CECI) is building on Western North Carolina's established expertise in regional, national and global climate analysis, its biodiversity and its digital arts expertise to turn climate data into services that provide decision-makers in many sectors with information that will enable them to adapt to and mitigate climate change.

Asheville is home to ten of the scientists and other experts who were recently awarded the Nobel Peace Prize for their work on the Intergovernmental Panel on Climate Change. The jewel in our growing climate services community is NOAA's National Climatic Data Center (NCDC), whose scientists are the stewards of the world's largest archive of environmental data. Many advantages in place in Asheville are making the city a center for capabilities to understand and address climate change.

For example, because mining the massive, high-resolution environmental databases and live data feeds flowing into NCDC takes immense amounts of bandwidth, it pays to be physically close to the archives. Plenty of bandwidth is available -- a high-capacity fiber optic network providing advanced telecommunications infrastructure is made possible by ERC Broadband **(www.ercbroadband.org)** and several public/private partnerships. ERC also provides high performance computing and secure data storage.

Another plus is NCDC's willingness to collaborate with experts in Asheville who have complementary skills. NCDC and the City of Asheville's former planning director, for instance, are partnering to develop a climate change manual for urban and rural planners.

Collaboration also brings together Asheville's scientists, artists, global information systems experts, mathematicians and other talented professionals. The Media Arts Project, or the MAP **(www.themap.org)**, cultivates innovative arts and technology in Western North Carolina. Its members include visualization experts who turn massive amounts of data into 3-D weather models that facilitate the making of policy creation and decisions.

Asheville's climate community also teams with nearby Oak Ridge National Laboratory, the Department of Energy's largest science and energy laboratory, and other agencies.



Visualization tools, including this geodome designed and produced by the Asheville-based company, The Elumenati, are a key component of the city's climate services skill set.

Respected educational programs in multimedia arts and sciences, engineering, and atmospheric, environmental, data, botanical and horticultural sciences at UNC Asheville, AB Tech, other area colleges and universities, and The North Carolina Arboretum provide excellent support to Asheville's climate services community.

Entrepreneurial support services, including AB Tech's Technology Commercialization Center, and a growing community of climate services and other knowledge-based companies are in place as well.

CECI is poised to orchestrate and grow Asheville's diverse climate services community so it becomes a national resource for trusted climate change information, innovative formal and informal education, natural resource impact analysis, and assistance with climate change management and decision-making. CECI is supported by the Asheville Hub, a nonprofit, community-based effort to promote a new economy for Asheville and Buncombe County that builds on existing strengths in technology, health care, creativity and other sectors.

Some of CECI's partners are described on the next page.

National Climatic Data Center

NOAA's National Climatic Data Center is a world leader in the climate community. NCDC archives the official historical weather records for the United States and provides climate services to every sector of the United States economy and to users worldwide. NCDC **(www.ncdc.noaa.gov)** offers vital clues about global warming, the effect of air quality and other climate-related developments.



More than 200 insurance, energy and transportation experts attended a recent NOAA user conference in Asheville, and most came to an event sponsored by Asheville's Centers for Environmental and Climatic Interaction to learn about Asheville's growing climate services community and how it can assist them.

The North Carolina Arboretum

An affiliate of the 16-campus UNC system, The North Carolina Arboretum **(www.ncarboretum.org)** showcases the biodiversity of Western North Carolina and provides leadership and administrative support to CECI. It is the site of the first weather station for the Climate Reference Network, a new, long-term study of climate change in the United States. The North Carolina Arboretum, the Western Office of the North Carolina Biotechnology Center, Bent Creek Institute and Mission Hospitals are partners in the cutting-edge research and discovery of medical treatments utilizing the matchless array of WNC's native species. Finding ways to protect these species as the climate changes is critical.

UNC Asheville

As the only designated liberal arts institution in the 16-campus University of North Carolina system, UNC Asheville **(www.unca.edu)** provides undergraduate programs in the arts, the humanities, the natural and social sciences, and in selected pre-professional programs. To enhance and extend the undergraduate programs, UNCA offers an interdisciplinary Master of Liberal Arts and is also in the planning process of a Master of Climate Change and Society.

NEMAC

The National Environmental Modeling and Analysis Center, or NEMAC **(www.unca.edu/nemac)**, a research center of UNC Asheville, approaches today's fundamental environmental challenges from a multidisciplinary view. NEMAC's strength is its ability to create partnerships and diverse collaborations within the academic community, the government and private enterprise.

U.S. Forest Service

The Southern Research Station of the United States Forest Service **(www.srs.fs.usda.gov)** is the leading organization for research on natural resource management and sustainability in the southern United States. It creates the science and technology needed to sustain and enhance Southern forest ecosystems and the benefits they provide.

RENCI at UNC Asheville

As part of the statewide Renaissance Computing Institute virtual organization **(www.renci.org),** this engagement site focuses on disaster research, mitigation and preparedness, taking advantage of Western North Carolina's expertise in weather and climate. RENCI at UNC Asheville draws on the community's longstanding excellence in the arts and combines scientific data with digital art so policy makers can better comprehend problems and their solutions.

A Sunny Outlook for Asheville's Climate Services Community

For businesses and research organizations that rely on climate and other environmental data and that want their employees to enjoy a superior quality of life, Asheville is the ideal location. NCDC has the data and the experts to help private companies understand the information that is in its archives -- data that companies can convert into commercial services at a time when decision-makers around the world need easily understandable, immediately useful information. Asheville consistently is recognized as a great place to live and as one of the top metros for business, careers and being an entrepreneur.

For More Information

For more information about CECI and how your organization can connect with Asheville's climate services community, contact Ron Gordon, CECI's director for economic development, at 828-231-0679 or rgordon@ncarboretum.org.

Revised 11/07

MINUTES
Legislative Commission on Global Climate Change
April 22, 2008

Welcome, attendance and opening remarks

The Legislative Commission on Global Climate Change met at 11 a.m., Tuesday, April 22, 2008 in Room 643 of the Legislative Office Building. Chairwoman Pricey Harrison presided. The meeting was called to order at 11:12 a.m.

Members present were Chairpersons Harrison and Mr. John Garrou, Senator Charlie Albertson, Representative Lucy Allen, Representative Charles Thomas, Representative Alice Graham Underhill, Representative Winkie Wilkins, Dr. Pete Andrews, Dr. Ryan Boyles, Mr. Thomas Cecich, Dr. Delores Eggers, Dr. George Everett, Mr. Robert Glaser, Mr. Preston Howard, Mr. Michael Nelson, Mr. Mitchell Peele, Dr. Daniel Phaneuf and Ms. Jane B. Preyer, Mr. Tim Profeta, Dr. Stanley Riggs, Mr. Robert Slocum, Dr. Stephen Smith, Mr. James Stephenson, Mr. Tim Toben, Ms. Susan Tompkins, Mr. Ivan Urlaub. Staff present were Commission Counsel George Givens, Assistant Counsel Jeff Hudson, Assistant Counsel Susan Iddings, Assistant Counsel Jennifer McGinnis, Commission Analyst Jennifer Mundt, Research Assistant Mariah Matheson, Commission Assistant Thelma Utley and substitute Commission Assistant Jessica Kozma Bennett.

Chairwoman Harrison welcomed members and visitors to the meeting, and noted that the State remained behind "the rest of the world" to keep up with climate change. She then asked for comments from fellow chairs, of which there were none.

Beginning **Item 3**, Chairwoman Harrison recognized Commission Counsel George Givens. Mr. Givens said that he had returned from a conference on coal reduction, adding that it was an excellent trip. He then reminded members to sign reimbursement sheets.

Presentation of the Results of the Intergovernmental Panel no Climate Change in the context of creating a greenhouse gas emissions reduction goal for the State of North Carolina
Item 4

Mr. Robert Jackson, Faculty Director of the Center of Global Climate Change and Professor of Biology and Environmental Sciences at Duke University was recognized by the chair. A copy of his presentation, entitled "educing Emission for Climate Stabilization" is attached to the minutes.

Mr. Jackson began reviewing his report to the Commission and said that all organizations have declared official climate change statements saying that the Earth is warming and human activities are creating such warming. He then showed a slide

depicting the Earth's existing climate, and said that there is more record hot weather than in times past. Last August through October were the hottest on record, he said, then moved to a graph depicting global surface warming. He continued reviewing his presentation, noting increases in temperatures juxtaposed to population growth.

Mr. Jackson also noted the higher lands were warming more quickly than tropical areas. Reviewing slides Mr. Jackson said that what policies we put in effect will have an "enormous" effect on the Earth's temperature.

In his report Mr. Jackson noted that there is a lot of inertia about emissions peaks, and that there is an even longer lag in stabilizing temperature. He added that the longest issue to climate change would be ice melting.

Reviewing a slide "Emission trajectories to stabilization" and "Trajectory of Global Fossil Fuel Emissions," Mr. Jackson said that the best consensus is to keep the world from warming would be within a range of 450 to 500 atmospheric CO(2). He added that currently the United States dominates in emissions but globalization and industrial development in China and India also contribute. He also reviewed slides on United States emissions, renewable technologies, point sources and reservoirs and local opportunities to reduce the human contribution to global warming.

He then thanked the Commission for their time. Chairwoman Harrison thanked him and opened the floor for questions and comments.

Representative Thomas inquired about ocean salinity in the wake of rising ocean levels due to Artic melting. Mr. Jackson replied water can melt in any area, and that fresh water flows into the oceans. He continued saying ocean circulation is a "great conveyor belt" Water warms at the equator then moves to the poles, dives down deeply into the ocean and can stay well under for up to 500 years. If this were to change, there would be enormous consequences, he said. But such an event is unlikely to happen in the 21st century.

Senator Albertson noted a presentation slide regarding a 2003 blackout in the Northeast. He asked how long the blackout lasted. Mr. Jackson replied a few days.

The slide reads that during the 2003 blackout visibility in the Northeast improved by 25 miles, and smog and ozone pollution dropped by half within a day, and gases contributing to haze and acid rain plummeted 90 percent.

Senator Albertson then noted that the blackout statistics make a good case for nuclear energy. Mr. Jackson said that in previous years he wrote editorial pieces on the intersection of nuclear energy and climate change.

Representative Allen commented that she found quotes on the first page of his report contradictory, adding that she thought that human action was contributing to global climate change, not causing it. She asked to hear from people who may have a different view.

Mr. Jackson said that the statements say a majority is through human activities.

Conversation continued. Mr. Givens asked that a handout be presented to Commission members and noted that there were five parts to the presentation. He added that it was a way to set goals, and said there needed to be a discussion of whether to have a goal to reduce carbon load. Mr. Garrou said the chairmen were not ready for a motion at the day's meeting but would rather keep the idea up for discussion. He also asked to have suggestions ready between now and the next meeting.

Presentation on electricity technologies in a carbon constrained world

Mr. Bryan Hannegan, Vice President of Environment and Generation for Electric Power Research Institute was recognized by Chairwoman Harrison to present a report entitled, "Electricity Technologies in a Carbon-Constrained World." A copy of his presentation in attached to the minutes. Mr. Hannegan skipped over the presentation's initial slides to begin a discussion on CO(2) reductions.

Reviewing the slide entitled "Electric Sector CO(2) Reduction Potential, Mr. Hannegan said reduction efforts are already in effect but that there is much more work to do. He then reviewed "Key Technology Challenges" (Slide 5). Challenges reviewed were a) enabling efficiency, PHEVs, DER via the Smart Distribution Grid; b) enabling intermittent renewables via advanced transmission grids; c) expanded advanced light water reactor deployment and d) advanced coal plants with CO(2) capture and storage.

Reporting on nuclear energy, Mr. Hannegan said that (slide entitled "Nuclear Energy") assumptions and necessities for successful nuclear energy include sustained safe, reliable economic operations; extend lifetimes beyond 60 years; and continue high capacity factors to the end of life. He said that it is one thing to build a new unit, but quite another to keep units running successfully. And more advances in materials were needed, he added.

Mr. Hannegan then reviewed a slide entitled "Electricity Technology Scenarios," which showed limited and full portfolio impacts on carbon capture, new nuclear and renewable supplies. Discussing potential impacts on electrical prices, Mr. Hannegan showed on a slide that limited wholesale electricity prices could increase 260 percent in the next fifty years and full wholesale energy up 45 percent.

Mr Hannegan closed his presentation and the Commission recessed at 1:50 for a fifty-five minutes lunch break.

The Commission reconvened at 2:45 p.m.

Presentation of final results of the macroeconomic analysis conducted on various climate mitigation options recommended by Climate Action Plan Advisory Group

Chairwoman Harrison recognized Mr. David W. Ponder, a graduate research assistant with the Department of Political Science/Criminal Justice at Appalachian State University. A copy of Mr. Ponder's presentation is attached to the minutes.

Mr. Ponder began his presentation discussing the impact analysis conceptualized the Nobel laureate Wassily Leontief. Input-output modeling, as it were, which describes the relationship among sectors of the economy; notes that outputs for one sector are inputs or another; that changes in consumption catalyze chain reaction of production; that multipliers measure ripple effect due to changes in demand. His work derived from "IMPLAN 2004."

Regarding sensitivity analysis, Mr. Ponder said there were several options for the Commission upon their request. He then reviewed three options selected primarily for the contribution of economic effects and carbon reductions.

- RCI1 Program is a utility investment in efficiency that is measured in energy savings realized. Two points were made. One, the estimates can overstate energy savings and loss of job production would result from this. Secondly, that on the "flip side," there would be more KPAC savings.
- Looking at local investment sensitivities, most spending would occur in the State economy.
- Increasing job in the energy industry would be of benefit to customers.

Presentation on the economics of climate change legislation in North Carolina

Mr. Ponder was thanked by Chairwoman Harrison. She then recognized Mr. David Tuerck, executive director of the Beacon Hill Institute for Public Policy Research and professor and chairperson of the Economics Department at Suffolk University. Mr. Tuerck thanked Chairwoman Harrison and the Commission.

Mr. Tuerck's presentation, "The Economics of Climate Change Legislation in North Carolina" is attached to the minutes. He began his presentation saying that he did not believe adopting global climate change recommendations would have a positive effect on the economy. He then reviewed several cost benefit analysis.

One, he suggested the utilities account for the capital integration and operation costs for projects; and that there should be an understanding of what constitutes a social benefit. He added that the only benefit to North Carolina consisted of reduced GHG emissions from North Carolina, as the state would still reap the consequences of such emissions from other states.

Mr. Tuerck continued that reductions in GHG fail to offer a cost benefit for the State, and because the net benefits are negative, a legitimate cost benefit analysis will show net losses, not gain. Meaning, he continued, less job and reduced investment.

He suggested that policy officials not fail to account for goods that must be sacrificed to capture reported savings. Multipliers should also not be used, and legislators and policy officials should not ignore price distortions and remember that job losses are a cost, not a benefit, to the State.

Continuing, Mr. Tuerck said job gains are a proxy for benefits but only when distortions are removed. Losses, he said, are a proxy for costs but only when distortions are created. And new jobs are of benefit only if they add more value than the jobs they displace. He then disputed claims from the two prior presentations. Please refer to the attached presentation.

Adjournment

The meeting was adjourned at 4:15 p.m.

Representative Pricey Harrison, Co-Chair, Presiding

Mr. John Garrou, Co-Chair

Minutes by Jessica K. Bennett

General Assembly of North Carolina

Legislative Commission on Global Climate Change

State Legislative Building Raleigh, North Carolina

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AGENDA

11:00 a.m. Tuesday 22 April 2008
Room 643 Legislative Office Building

1. Call to order
   Representative Pricey Harrison, Presiding

2. Introductory remarks by Cochairs *(5 minutes)*
   Representative Pricey Harrison
   John. L. W. Garrou

3. Report to the Commission and explanation of agenda items *(10 minutes)*
   George F. Givens, Commission Counsel

4. Presentation of the results of the Intergovernmental Panel on Climate Change in the context of creating a greenhouse gas emissions reduction goal for the State of North Carolina *(45 minutes)*
   Robert B. Jackson, Faculty Director, Center on Global Change, and
   Professor of Biology and Environmental Sciences, Duke University

12:50 5. Presentation on electricity technologies in a carbon-constrained world *(30 minutes)*
   Bryan Hannegan, Vice President of Environment and Generation
   Electric Power Research Institute

LUNCH 12:30 p.m. to 1:15 p.m.

6. Presentation of final results of the macroeconomic analysis conducted on various climate mitigation options recommended by Climate Action Plan Advisory Group (CAPAG) *(30 minutes)*
   David W. Ponder, Graduate Research Assistant
   Department of Political Science/Criminal Justice, College of Arts and Sciences
   Appalachian State University

1:45

3:15 p.m.

7. Presentation on the economics of climate change legislation in North Carolina *(30 minutes)*
   David G. Tuerck, Executive Director,
   Beacon Hill Institute for Public Policy Research, and
   Professor and Chairperson, Economics Department, Suffolk University

8. Response to economic and jobs analysis presentations *(15 minutes)*

9. Commission discussion and announcements

10. Adjourn 4:15

SCHEDULE OF FUTURE MEETINGS:

The Cochairs and Counsel have established the following schedule of meetings of the Legislative Commission on Global Climate Change for the 2007-2008 Legislative Interim. Except as noted, all meetings are scheduled for 10:00 a.m. This schedule is subject to revision.

Commission Meeting	**Location**
Wednesday 7 May 2008	544 Legislative Office Building

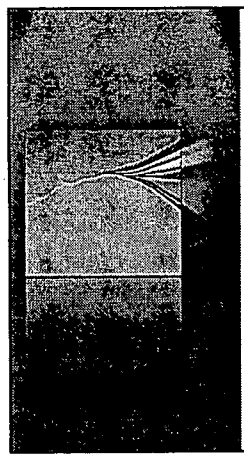
COMMISSION WEBSITE:

In order to provide public access to the materials distributed at the meetings of the Commission and to other documents related to the Commission, a website has been developed for the Commission. The website can be viewed online at the following address:

http://www.ncleg.net/gascripts/Committees/Committees.asp?sAction=ViewCommittee&sActionDetails=Non-Standing_6268

ADDITIONAL INFORMATION:

Persons having questions about the Commission meeting or other matters related to the Commission may contact Commission Counsel or other Commission staff at (919) 733-2578.



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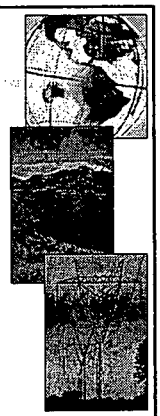
Electricity Technologies in a Carbon-Constrained World

North Carolina Legislative Commission
April 22, 2008

Bryan Hannegan
Vice President, Environment & Generation

EPRI

About EPRI



Together...Shaping the Future of Electricity

- Founded in 1973 as an independent, nonprofit center for public interest energy and environmental research.
- Objective, tax-exempt, collaborative electricity research organization
- Science and technology focus–development, integration, demonstration and applications
- Broad technology portfolio ranging from near-term solutions to long-term strategic research

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Insights from Recent EPRI Work

- The technical potential exists for the U.S. electricity sector to significantly reduce its CO_2 emissions over the next several decades.
- No one technology will be a silver bullet – a portfolio of technologies will be needed.
- Much of the needed technology isn't available yet – substantial R&D, demonstration is required.
- A low-cost, low-carbon portfolio of electricity technologies can significantly reduce the costs of climate policy.
- Flexible, market-based climate policies offer significant economic advantage over sector-specific approaches

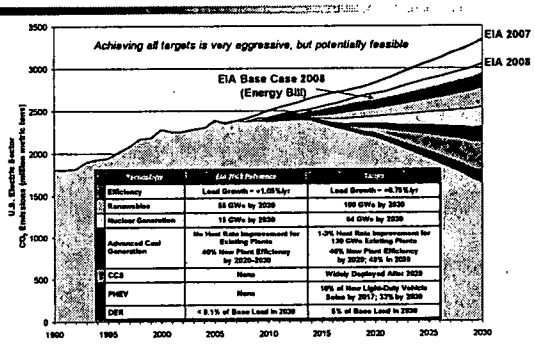
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How is the electricity industry preparing for a carbon-constrained world?

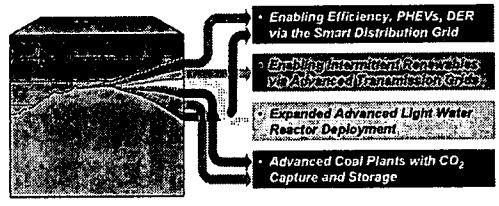
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Electric Sector CO_2 Reduction Potential



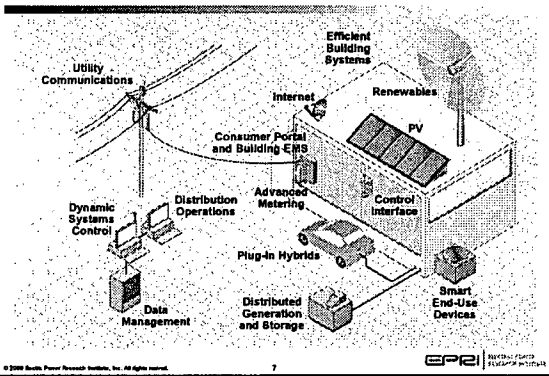
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Key Technology Challenges



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"Smart" Grid for Efficiency and Renewables



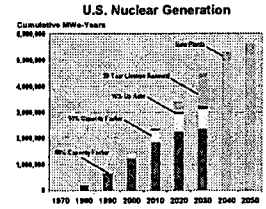
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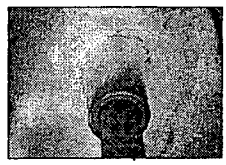
Nuclear Energy

Assumption and Necessity

- Sustained safe, reliable, economic operation
- Extended lifetimes – beyond 60 years
- Continued high capacity factors to end of life

U.S. Nuclear Generation



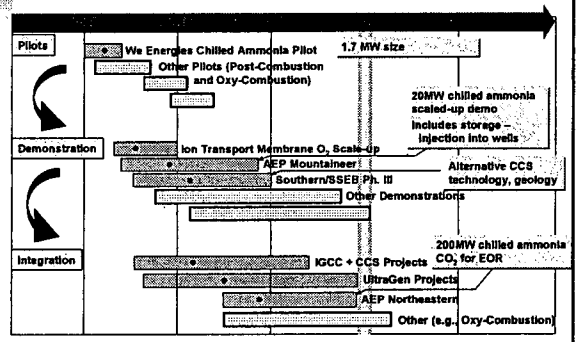


Technological Advances Required

- Materials inspection, repair and replacement
- Prognostic technologies
- More extensive use of digital technology
- Cable diagnostics and alternative replacements
- Fuel performance

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Coal with CO_2 Capture and Storage



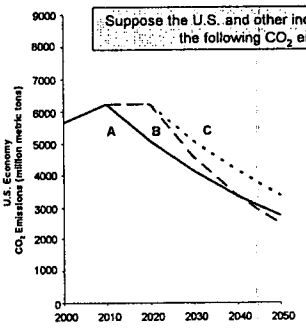
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How can advanced technology reduce the costs of climate policy?

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Future CO_2 Emissions Scenarios

Suppose the U.S. and other industrialized nations adopt one of the following CO_2 emissions constraints:



Policy Scenario A:
- 2%/yr decline beginning in 2010

Policy Scenario B:
- Flat between 2010 - 2020
- 3%/yr decline beginning in 2020
- Results in "prism"-like CO_2 constraint on electric sector

Policy Scenario C:
- Flat between 2010 - 2020
- 2%/yr decline beginning in 2020

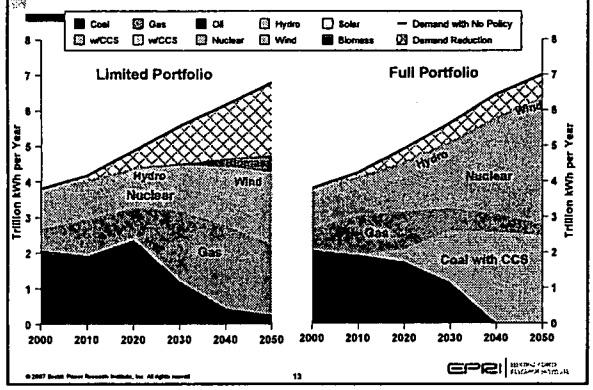
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Electricity Technology Scenarios

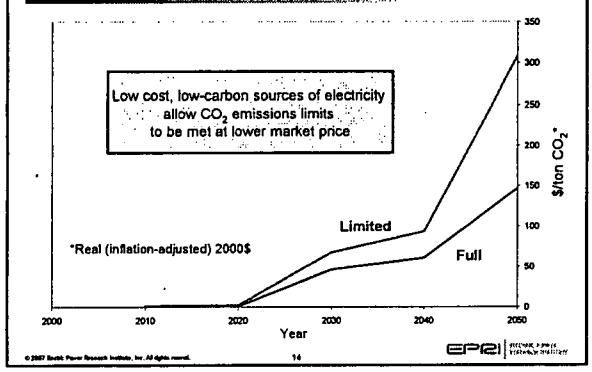
	Limited Portfolio	Full Portfolio
Supply-Side		
Carbon Capture and Storage (CCS)	Unavailable	Available
New Nuclear	Existing Production Levels ~100 GW	Production Can Expand
Renewables	Costs Decline	Costs Decline Further
New Coal and Gas	Improvements	Improvements
Demand-Side		
Plug-in Hybrid Electric Vehicles (PHEV)	Unavailable	Available
End-Use Efficiency	Improvements	Accelerated Improvements

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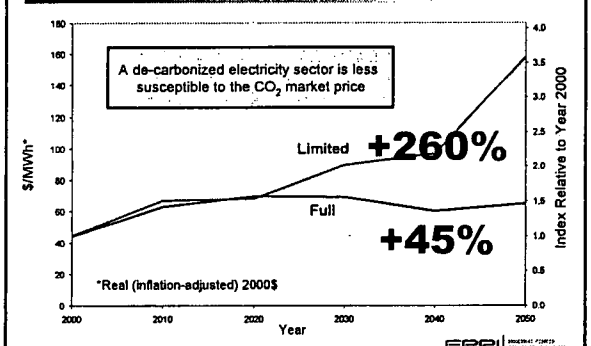
Impact on Future U.S. Electricity Mix



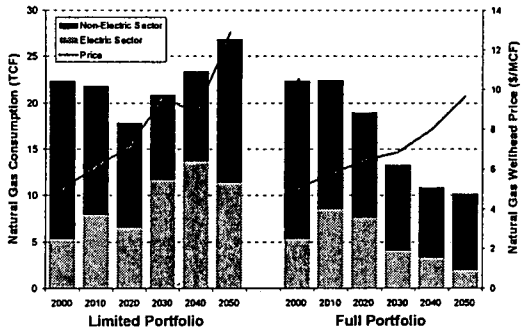
Impact on Carbon Prices



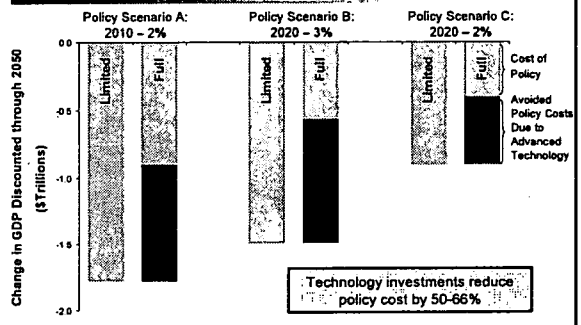
Impact on Wholesale Electricity Prices



Impact on Natural Gas Markets

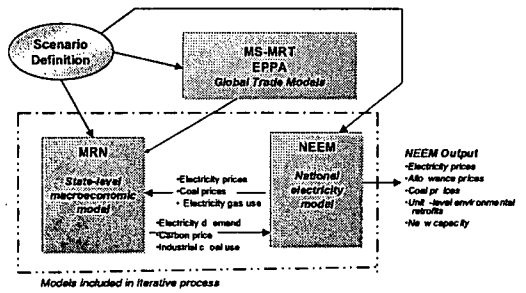


Impact on U.S. Economy



How might the specific details of climate policy design make a difference?

EPRI/CRA Study of CA Climate Policy



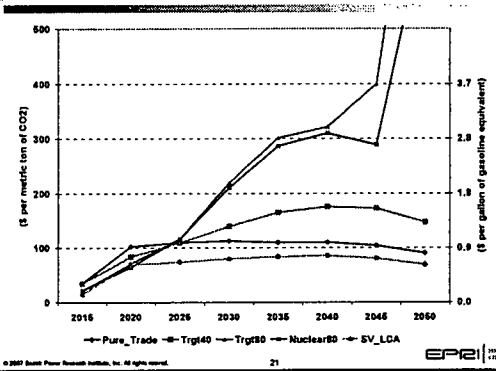
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California AB 32 Implementation Study

- **AB 32 sets emissions limit of 1990 levels by 2020; look at 20 different implementation scenarios, e.g.**
  - **Pure Trade** – Comprehensive cap-and-trade program with standard assumptions about technology, except no new nuclear and renewables-only imports
  - **LCA** –low-cost-assumptions: high end energy efficiency, lowest capital costs for renewables, rapid introduction rate of non-emitting transportation backstop, doubling DSM benefits of "DSM Benefit" case
  - **SV-LCA** – Same as Pure Trade but with price safety-valve set at CO_2 price in scenario with low-cost-assumptions (LCA)
  - **Trgt40** – In 2050, achieve 40% emissions reduction below 1990 levels, with no new nuclear and renewables-only imports
  - **Trgt80** – In 2050, achieve 80% emissions reduction below 1990 levels, with no new nuclear and renewables-only imports
  - **Nuclear80** – Same as Trgt80, but allow unrestricted imports of nuclear
  - **RPS 20** – Meet State Renewable Portfolio Standard (RPS) of 20% renewable energy by 2020, but don't impose an overall emissions cap

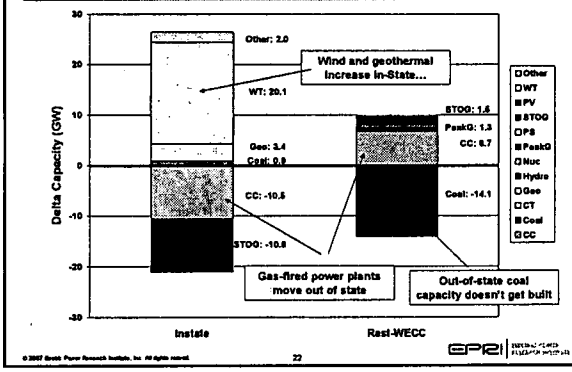
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California CO_2 Permit Prices

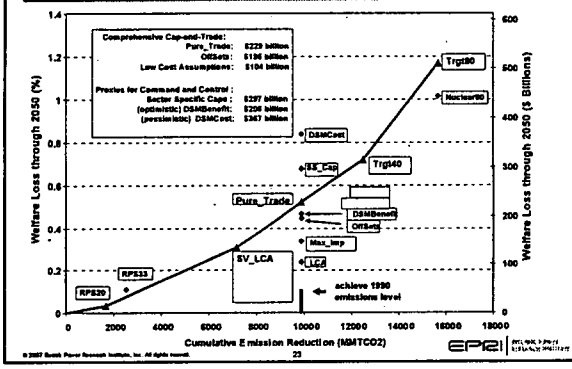


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Regional Generation Mix Changes



Economic Costs to California Economy



Implementation Details Make a Difference

All potential scenarios show real economic costs to state
- Costs ranged from -0.24% to -1.17% through 2050

Broad, market-based cap-and-trade policies are most cost-effective
- Command-and-control or sector-specific caps are more costly
- Allowance price "safety valve" would limit costs, but limit CO_2 reduced

Electric sector plays a pivotal role in achieving CO_2 targets
- Changes in power imports, instate generation mix result
- Electrification of other sectors enables them to meet their CO_2 goals
- Cost estimates do not include "system stability" costs

Several elements of State policy need careful examination
- CAT estimates of in-state forestry offsets → $33 billion savings
- Stronger rules to prevent "leakage" would drive up costs

Insights from Recent EPRI Work

- The technical potential exists for the U.S. electricity sector to significantly reduce its CO_2 emissions over the next several decades.
- No one technology will be a silver bullet – a portfolio of technologies will be needed.
- Much of the needed technology isn't available yet – substantial R&D, demonstration is required.
- A low-cost, low-carbon portfolio of electricity technologies can significantly reduce the costs of climate policy.
- Flexible, market-based climate policies offer significant economic advantage over sector-specific approaches

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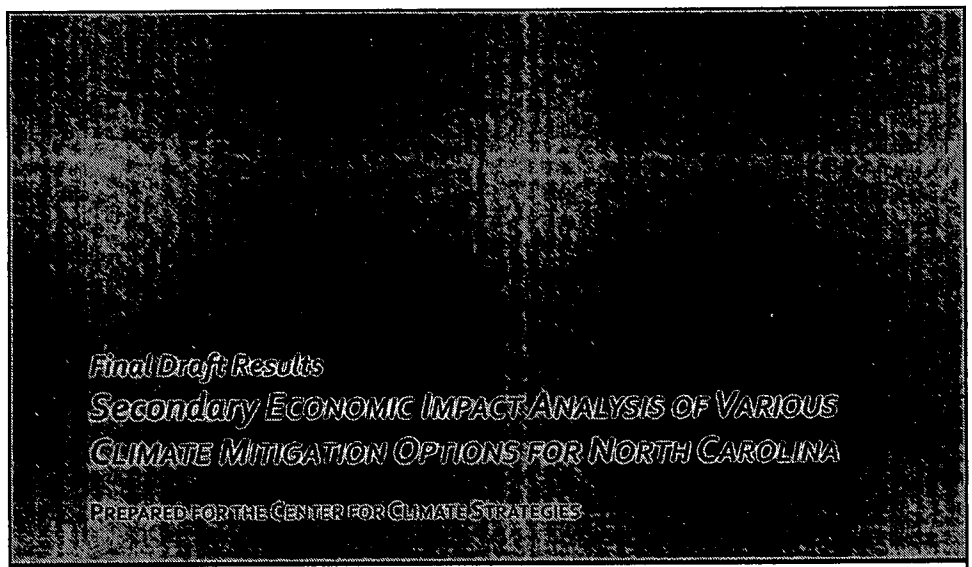
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Implications for State Policy Design

1. You get what you pay for; higher cuts = higher costs
   - Non-emitting sources of energy by definition more expensive
2. Traditional regulatory approach unlikely to be effective by itself
   - Not "end-of-pipe"; requires transformation of energy system
   - Not short-term, specific; is long-term (100 yrs), global, economy-wide
3. Timing of low-carbon technology availability is a key cost driver
   - Necessary technologies are NOT at hand, if you care about cost
   - Need full range of "market pull" and "technology push" activities
4. Electric sector plays primary role in broader de-carbonization
   - Provides low-cost, low-carbon fuel to replace direct fossil use
   - Can be inhibited by sector-specific approaches
5. States alone cannot drive climate change policy
   - Linkage to national, international policies must be kept in mind

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N.C. Legislative Commission on Global Climate Change

David W. Ponder

April 22, 2008

Appalachian State University

N.C. Energy Scenario Economic Impact Model

- Developed in 2005 for the N.C. Energy Policy Council
  - Skip Laitner, U.S. Environmental Protection Agency
  - Doug Arent, National Renewable Energy Laboratory
  - Christopher Larsen, ABB Group
  - Jeffry Tiller, Appalachian State University Energy Center
- Peer reviewed by Adam Rose, PhD. Univ. of Southern California
- Served as basis for similar analysis in Arizona, Colorado, Florida, Iowa, Michigan, Ohio, and Texas

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Appalachian State University

Input-Output Modeling

- Conceptualized by Nobel laureate Wassily Leontief
  - Describes relationship among sectors of economy
  - Outputs for one sector are inputs for another
  - Changes in consumption catalyze chain reaction of production
  - Multipliers measure ripple effect due to changes in demand
  - Derived from IMPLAN 2004
- Core of NCESEIM
  - 39 x 39 Economic Sector Matrix

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Impact Analysis

- Impact model captures direct, indirect, induced effects
- Employment
  - Full time equivalents
- Income
  - Employee compensation & proprietor income
- Total Value Added
  - Income
  - Rents, royalties, dividends & profits
  - Indirect business taxes

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Key I-O Assumptions

- Static Production Functions
- Constant Returns to Scale
- Homogenous Personal Consumption Functions
- No Supply-Side Constraints
- Endogenous

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Final Draft Results
Secondary Economic Impact Analysis of Bundled Climate Mitigation Options
Appalachian State University Energy Center

Policy selection and bundling

- 22 bundles representing 30 policy options
  - 6 Energy Supply
  - 10 Residential, Commercial, Industrial
  - 11 Agriculture, Forestry, Waste
  - 3 Transportation & Land Use
- Represent more than 90% of greenhouse gas emissions reductions

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Final Draft Results

Secondary Economic Impact Analysis of Bundled Climate Mitigation Options

Appalachian State University Energy Center

Energy Supply Options
ES-1, ES-2 & AFW-5: Renewable Energy Production Subsidy, Renewable Portfolio Standard, & Biomass Production Subsidy
ES-3 & ES-9: Combined Heat and Power
ES- 6a & 6b: Advanced Coal Technologies
ES- 8: Municipal Biogas
Residential, Commercial, & Industrial Options
RCI-1, RCI-2 & RCI-11: Energy Efficiency Funding & Energy Audits
RCI-4 & RCI-5: Market Transformation & Appliance Standards
RCI-6: Energy Codes
RCI-7 & RCI-3: High Performance Buildings
RCI-9: Bulk Purchasing for Energy Efficient Appliances
RCI-10: Solar Water Heating Only
Agriculture, Forestry, & Waste Management Options
AFW-1: Manure Digesters
AFW-2: Biodiesel Production Subsidy
AFW-4a & AFW-4b: Conservation Easements
AFW-6: Cellulosic Ethanol Production Subsidy
AFW-8: Afforestation
AFW-9 & AFW-10: Forest Management
AFW-11: Landfill Gas
AFW-12: Recycling
AFW-13: Urban Forestry
Transportation & Land Use Options
TLU-1b: Multi-modal Transportation and Promotion
TLU-3a: Vehicle Registration Surcharge to Fund Multi-modal Transportation
TLU-5: Tailpipe Greenhouse Gas Emissions Standards

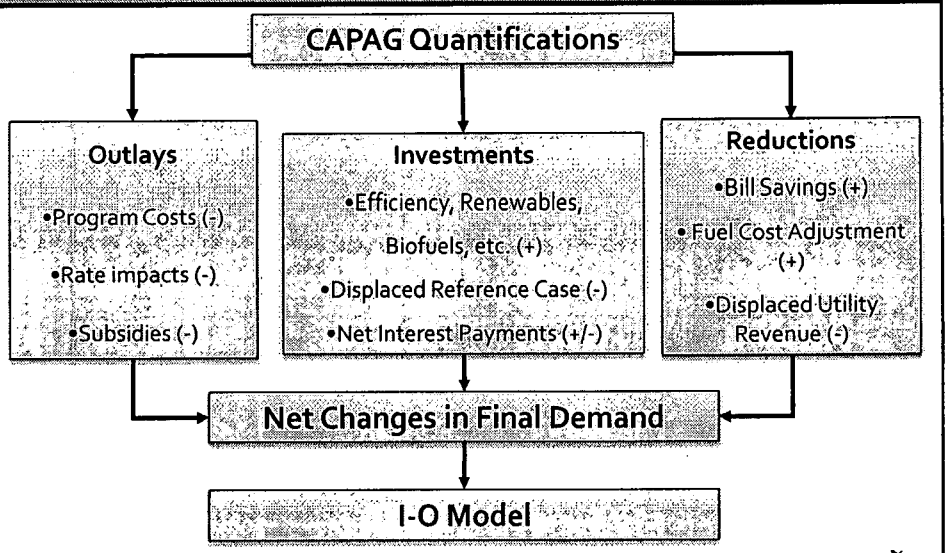
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Summary Results for All Options

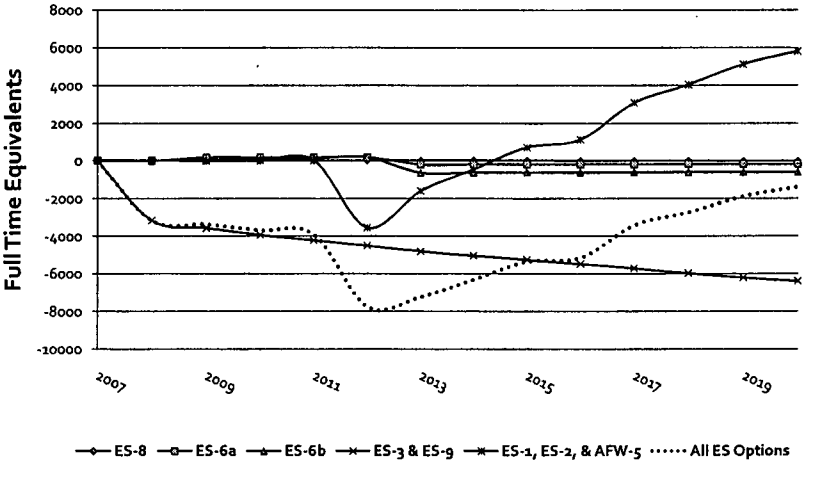
	Net Annual Employment (FTE)			Net Income ($2004, million)				Total Value Added ($2004, million)			
	2010	2015	2020	2010	2015	2020	2007-2020 NPV	2010	2015	2020	2007-2020 NPV
Energy Supply Options	(3,707)	(6,311)	(3,099)	(170)	(296)	(129)	(1,901)	(329)	(584)	(361)	(3,840)
Residential, Commercial & Industrial Options	6,611	11,703	13,934	285	519	638	3,761	375	560	521	4,123
Agriculture, Forestry & Waste Management Options	4,183	7,692	15,500	189	386	866	3,232	340	691	1,527	5,792
Transportation & Land Use Options	2,061	1,993	6,090	62	63	288	706	133	151	567	1,523
All Options	9,149	15,077	32,424	366	673	1,663	5,799	520	817	2,254	7,598

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Net Employment Impact of Energy Supply Options

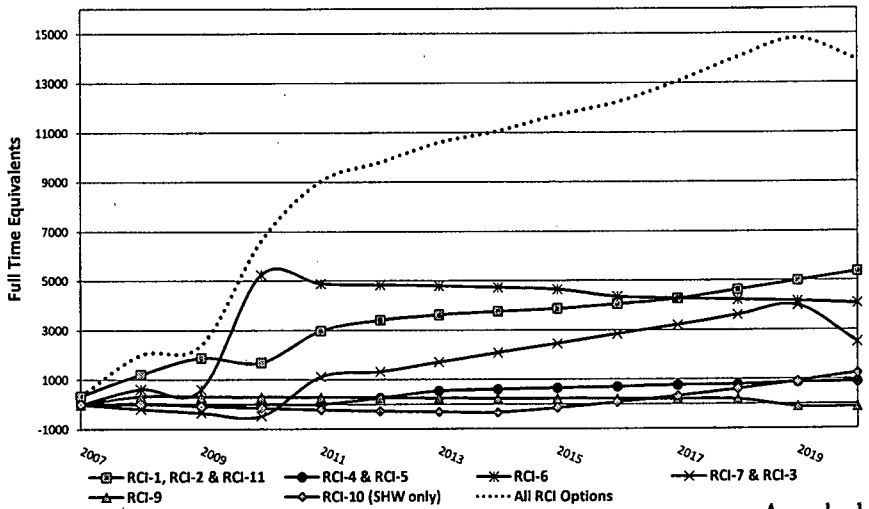


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Net Employment Impact of Residential, Commercial & Industrial Options

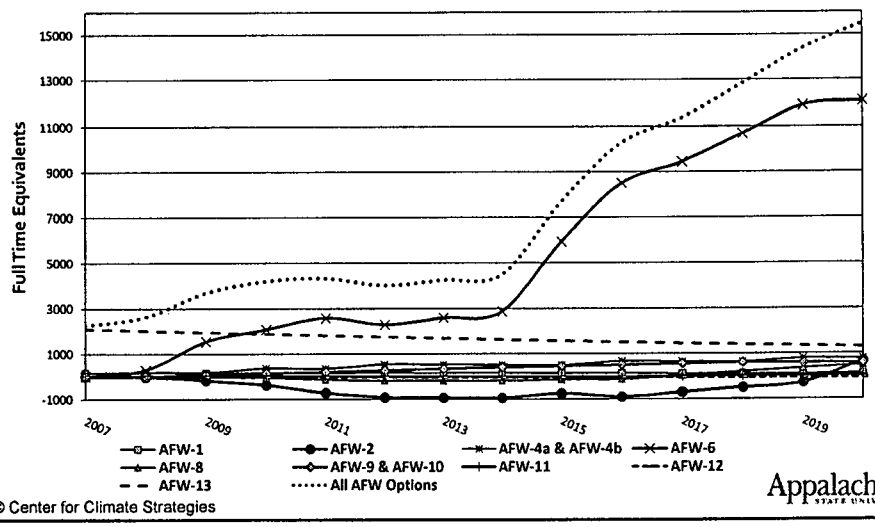


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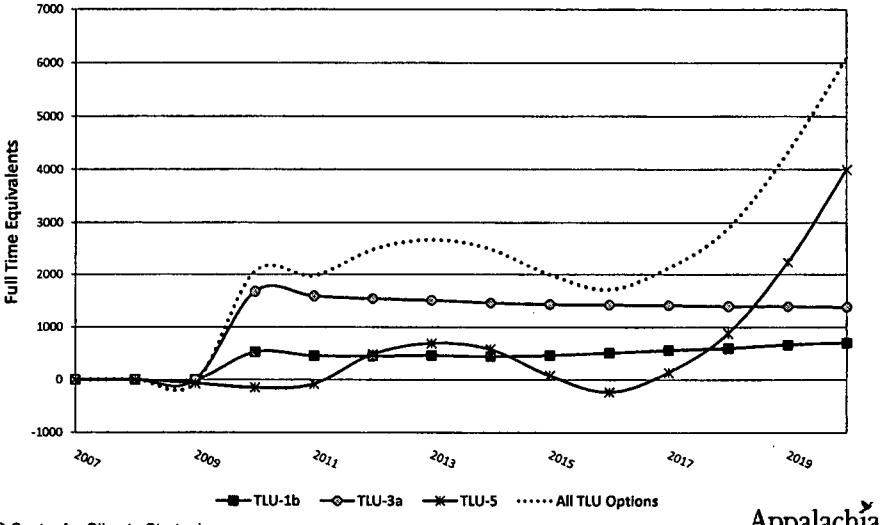
Net Employment Impact of Agricultural, Forestry & Waste Options



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Net Employment Impacts of Transportation & Land Use Options



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Sensitivity Analysis

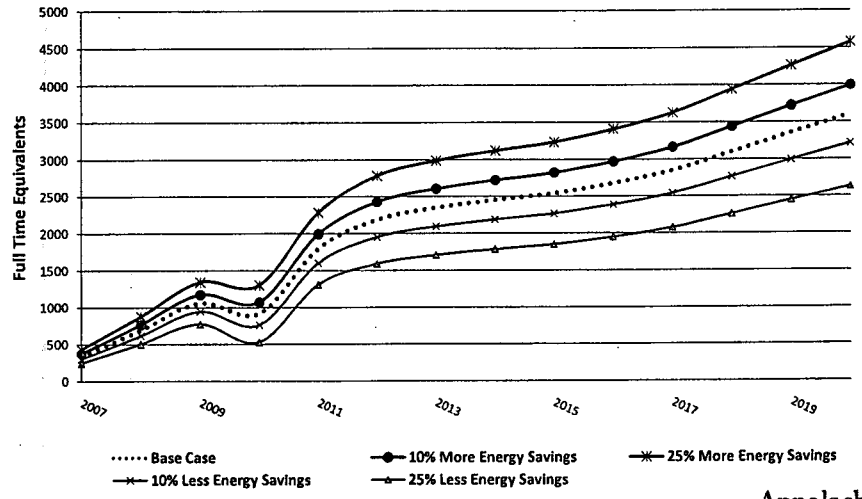
- RCI-1: Energy Efficiency Funding
  - Program Effectiveness (energy savings realized)
  - Local Investment
  - Multipliers
- TLU-5: GHG Standards for Automobiles
  - Fuel Prices
  - Compliance Costs
- AFW-6: Subsidies for Cellulosic Ethanol
  - Feedstock Price Sensitivities

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Effect of Program Effectiveness on Employment Impacts of RCI 1

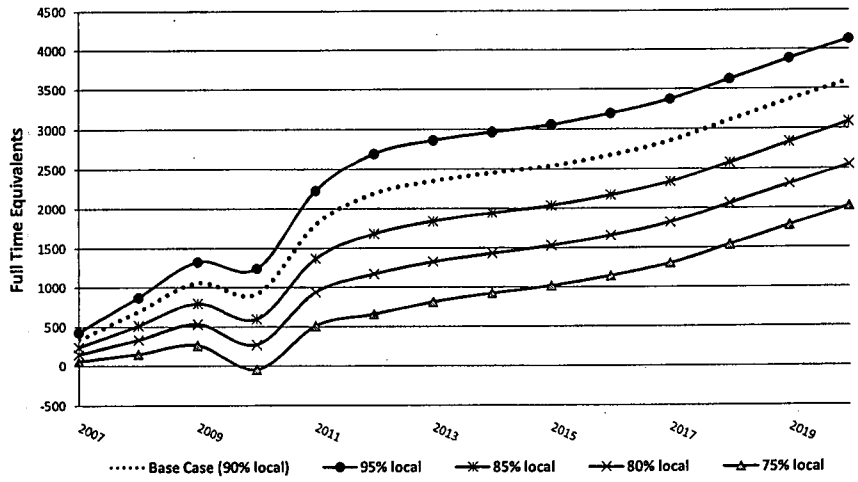


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Effect of Local Investment Sensitivities on Employment Impacts of RCI 1



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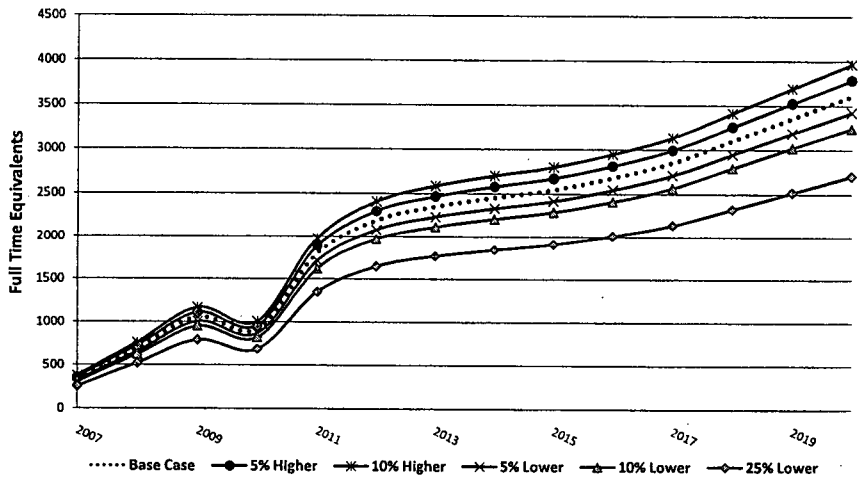
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Effect of Multiplier Sensitivities on Employment Impacts of RCI 1



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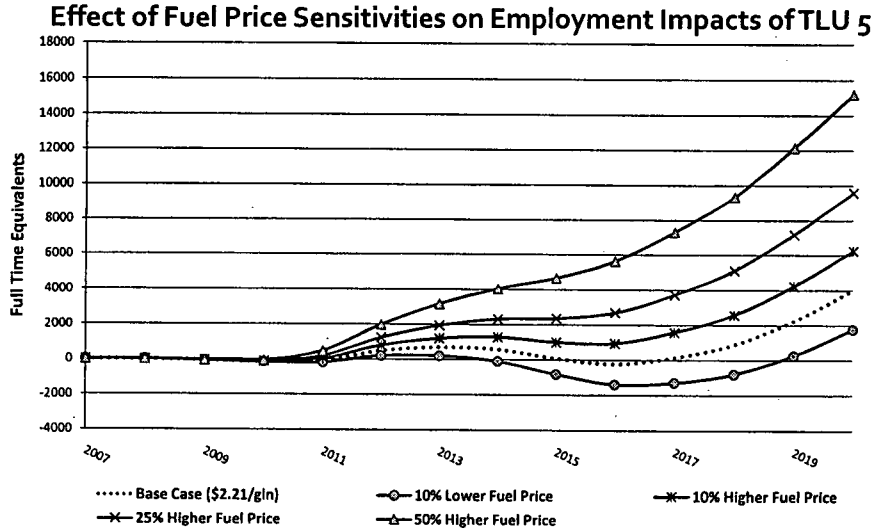
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Effect of Fuel Price Sensitivities on Employment Impacts of TLU 5



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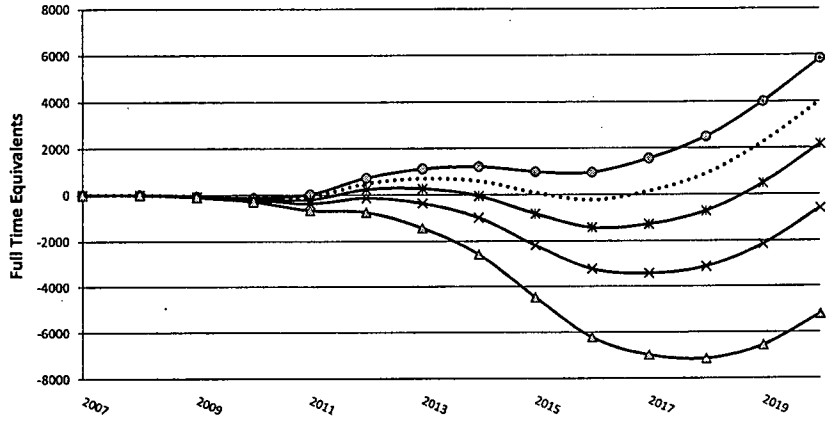
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Effect of Compliance Cost Sensitivities on Employment Impacts of TLU 5



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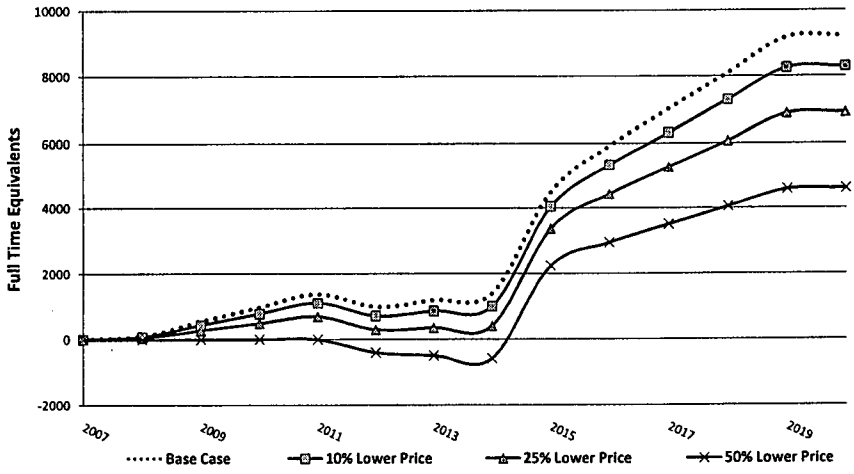
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Effect of Feedstock Price Sensitivities on Employment Impacts of AFW 6*



*Excludes Capital and O&M Investments

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Acknowledgements

- CCS Team
  - Dan Wei, David Von Hippel, Alison Bailie, Bill Dougherty, Stephen Roe, Randy Strait, Kathryn Bickel & Tom Peterson
- ACEE
  - Skip Laitner
- ASU Energy Center
  - Jason Hoyle, Jeffery Tiller & Dennis Grady

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Secondary Economic Impact Analysis of Various Climate Mitigation Options for North Carolina

Prepared for the Center for Climate Strategies

N.C. Legislative Commission on Global Climate Change

David W. Ponder

April 22, 2008

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Legislative Commission on Global Climate Change — 04/22/2008

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DAREN BAKST	John Locke Fdn
TOM BEAN	EDF NCSEA
Bryan Hannegan	EPRI Palo Alto, CA
JOHN HUTCHINSON	EPRI, 1300 W. W.T. HARRIS BLVD. CHARLOTTE, NC 28262
Vernon Cox	DSWC, Archdale Bldg.
Bryant Kinney	Duke Energy
Scott Gardner	Duke Energy
Lisa Riegel	NHF
Peter Raabe	American Rivers
Jim Southerland	J H Southerland Consulting

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DAVID BARNES	Poyner + Spruill
Robin Smith	DENR
Cam Stefanski	DENR / DCM
Steve Underwood	DENR/DCM
Grant Blume	Progress Energy
Erin Kinney	NC Conservation Network
Christin Danchi	Rep. Stam
Karen Jadlow	Electricities
Mia Bailey	Electricities

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Patrick Buffkin	Nelson Mullins
Zeb alley	" "
Tommy Stevens	NCPC
Henry Jones	Attorney Raleigh
David Bass	Carolina Journal
Geoff Lawrence	John Locke Foundation
John Goodman	NC Chamber
[illegible]	NC AEC
W Kelly	520 Winter
Amy Fuller	1599 W
David Ponder	ASU Energy Center

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Dan Crawford	Conservation Council of NC
Kim Garlett	NC- Public Staff
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Randy Strait	CCS
Kris Coracini	EDF
Elizabeth Ouzts	Environment North Carolina
Mio Bailey	Electricities
Sharon Miller	CUCA
Casandra White	Gov. Office

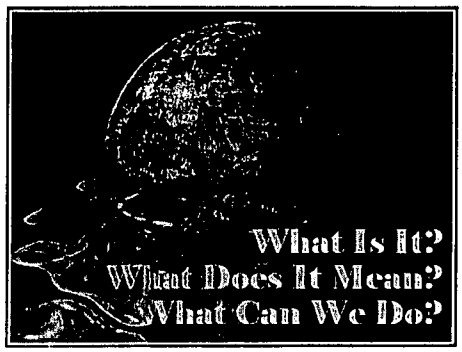
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Michael Regan	EDF
Phil Morgan	Piedmont Natural Gas P.O Box 17086 Greensboro NC
Linda Rimier	US EPA
Libby Switzer	Commerce
Manly Wilder	DENR
Pat Harris	DENR
Leslie Kleczek	Nicholas Institute, Duke U.
Amy Simes	DENR
Sushma Masemore	DENR
Ulla Reeves	So. Alliance for Clean Energy



Reducing Emissions for Climate Stabilization

Rob Jackson

NC LCGCC, 22 April 2008

jackson@duke.edu

Duke Biology

NICHOLAS SCHOOL OF THE ENVIRONMENT AND EARTH SCIENCES
DUKE UNIVERSITY

CENTER ON GLOBAL CHANGE
DUKE UNIVERSITY

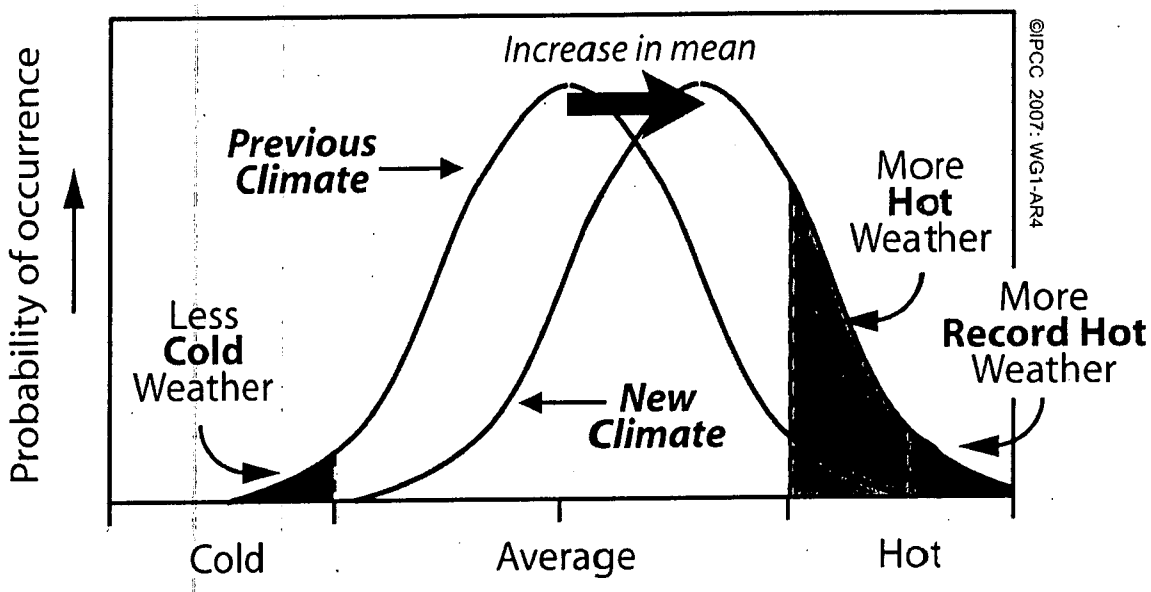
Recent reports conclude that increased greenhouse gas concentrations are warming the earth

"Greenhouse gases are accumulating in Earth's atmosphere as a result of human activities, causing surface air temperatures and subsurface ocean temperatures to rise."
National Academy of Sciences, 2001

"Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level.
Intergovernmental Panel on Climate Change, 2007 synthesis, >2,000 scientists

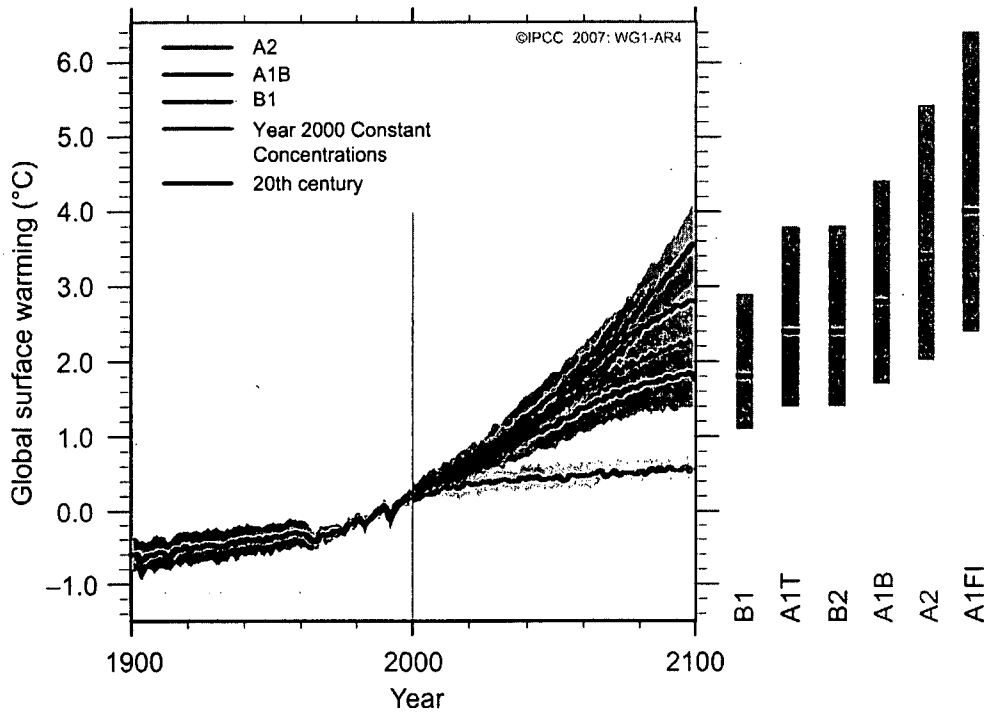
"Because human activities are contributing to climate change, we have a collective responsibility to develop and undertake carefully considered response actions."
American Meteorological Society, Official statement, >11,000 meteorologists, 2003

"Scientific evidence strongly indicates that natural influences cannot explain the rapid increase in global near-surface temperatures observed during the second half of the 20th century." American Geophysical Union, >42,000 Earth scientists, Official climate change statement, 2005



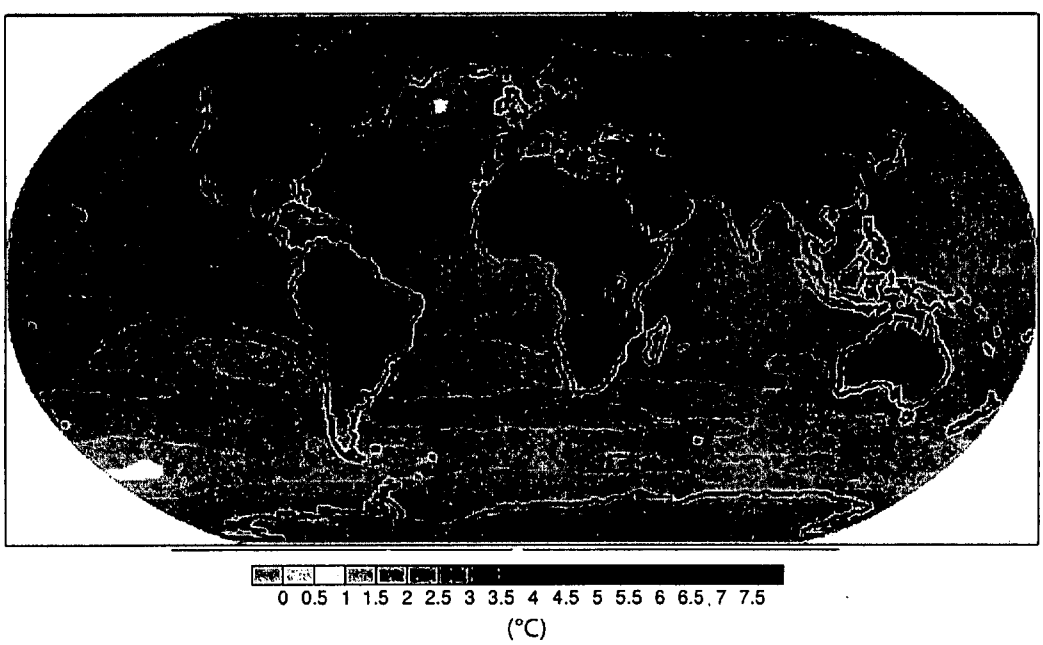
Preparation and Review of the WG1 AR4

- Each report is an assessment of the state of understanding based upon peer-reviewed published work. IPCC assesses published research but does not do research. Each assessment goes through multiple reviews and revision and re-review over a period of years.
- Informal draft prepared, comments sought from 6-12 outside experts for each chapter (Oct 2004 - Mar 2005).
- Formal first order draft (FOD) reviewed by about 600 reviewers worldwide (Sept -Nov 2005).
- Formal second order draft (SOD) re-reviewed by about 600 experts worldwide and by dozens of governments (April-May 2006).
- Govt comments on revised Summary for Policy Makers (Oct-Nov 2006).
- WG1 received and considered over 30000 comments in total.
- The assessment conclusions are not the views of any single scientist, but reflect a much broader process.

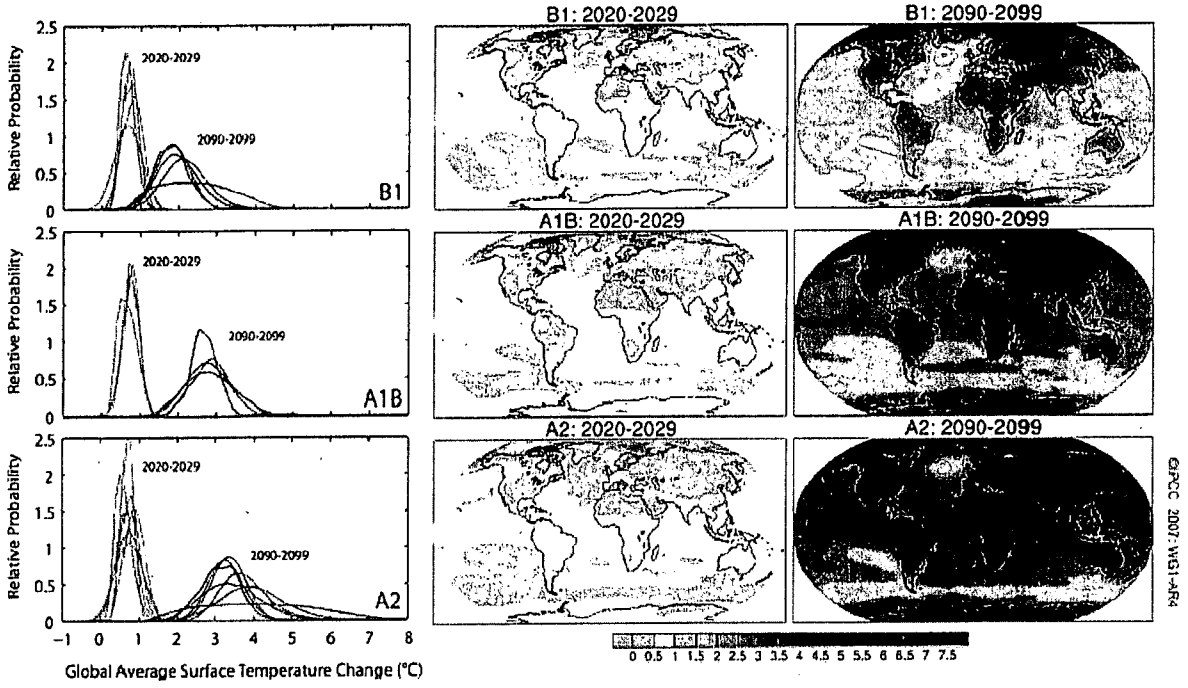


A1B is a medium scenario: Global mean warming 2.8°C;
Much of land area warms by ~3.5°C
Arctic warms by ~7°C; would be less for less emissions

(Years 2090-2099)

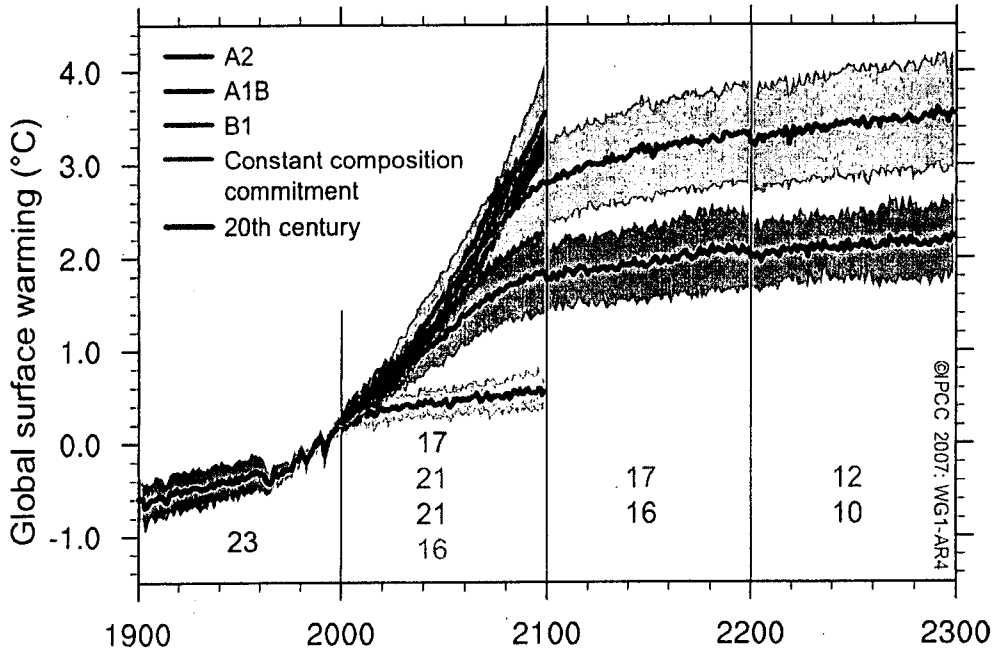


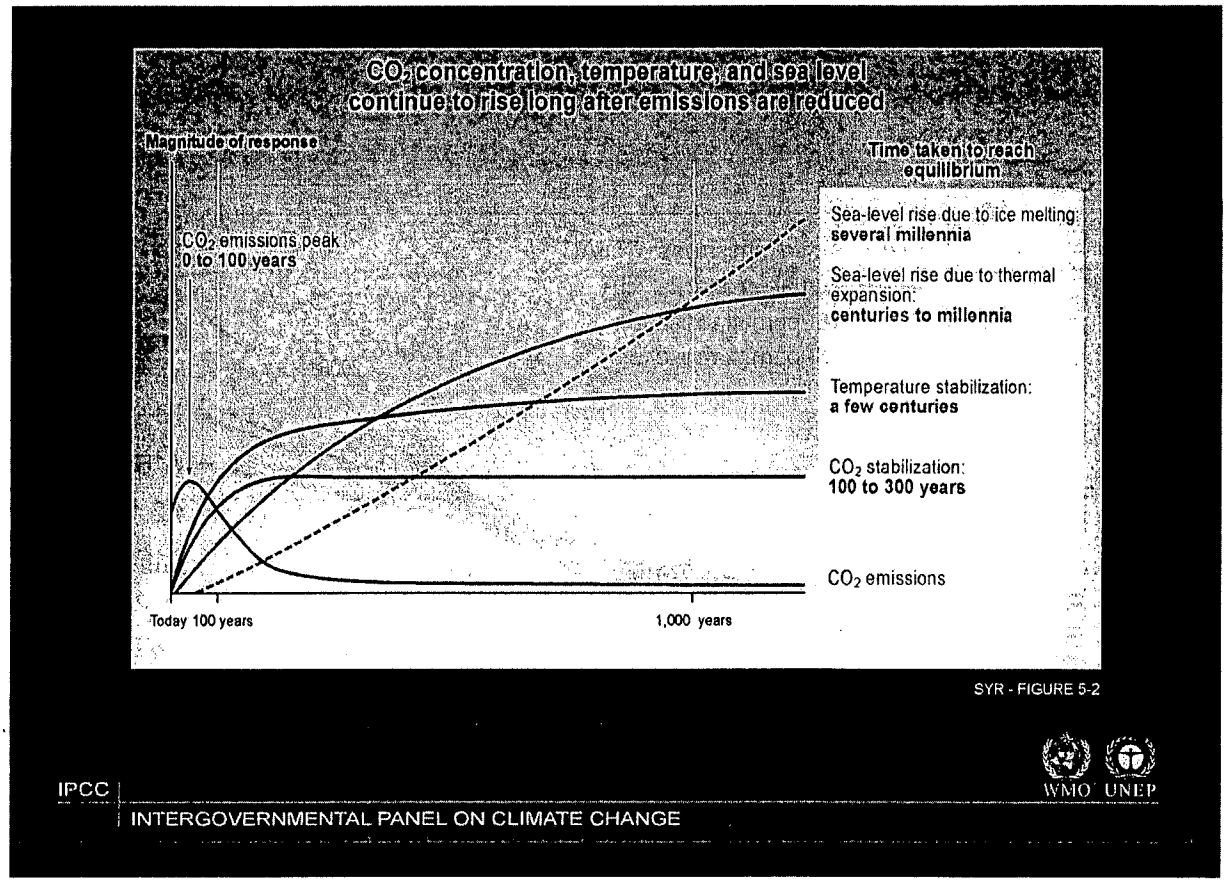
AOGCM Projections of Surface Temperatures

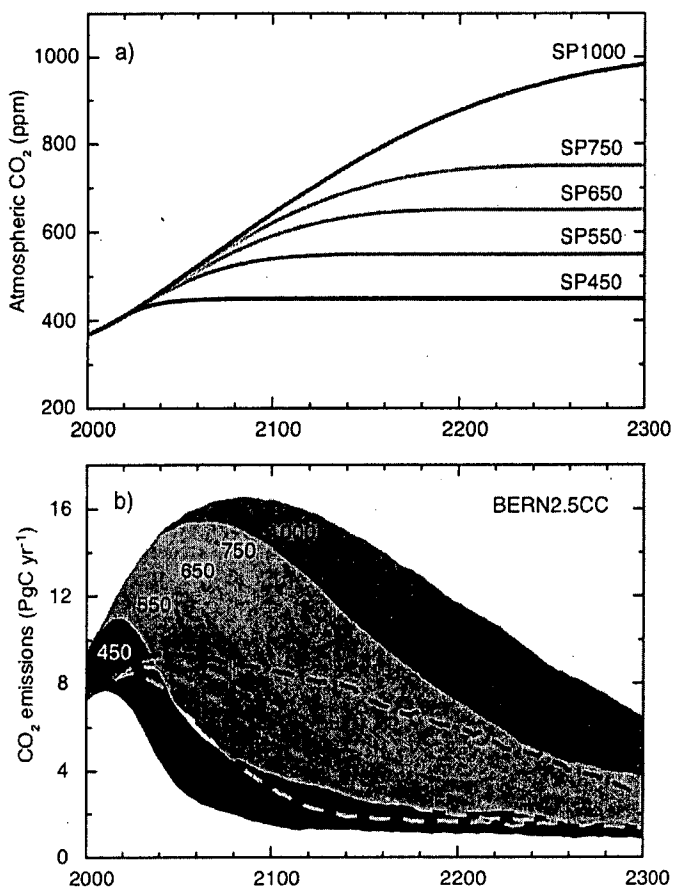


What's in the pipeline and what could come

Warming will increase if GHG increase. If GHG were kept fixed at current levels, a committed 0.6°C of further warming would be expected by 2100. More warming would accompany more emissions.

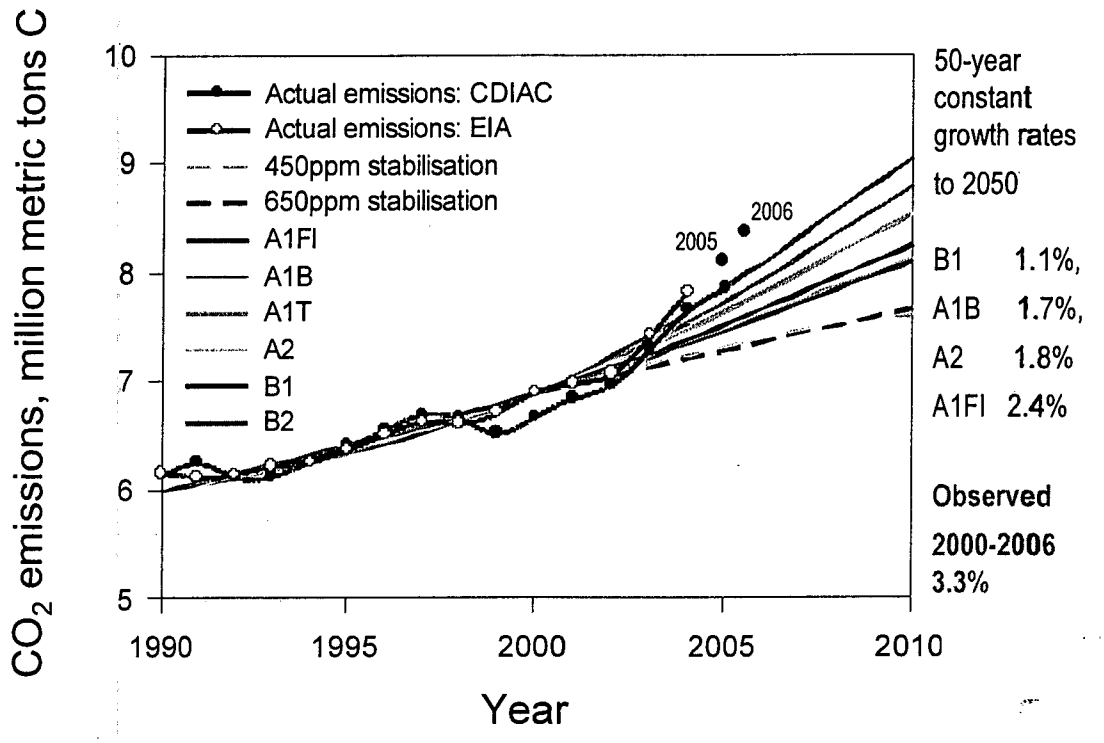






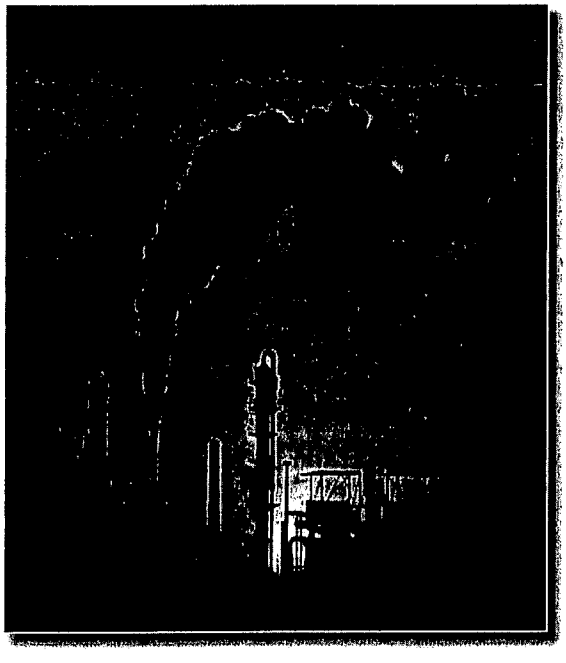
Emission trajectories to stabilization

Trajectory of Global Fossil Fuel Emissions



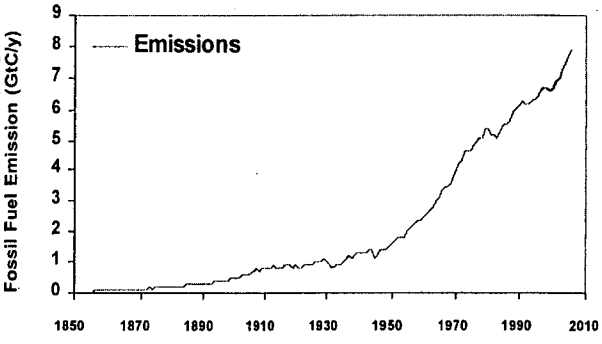
Raupach et al. 2007, PNAS

Anthropogenic C Emissions: Fossil Fuel



2006 Fossil Fuel: 8.4 Pg C

[2006-Total Anthrop. Emissions:8.4+1.5 = 9.9 Pg]



1990 - 1999: 1.3% y^{-1}

2000 - 2006: 3.3% y^{-1}

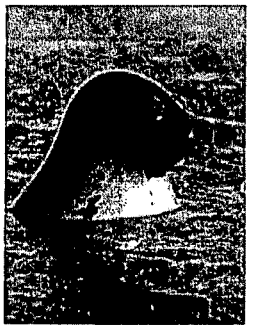
Raupach et al. 2007, PNAS; Canadell et al 2007, PNAS



The Scientific Report





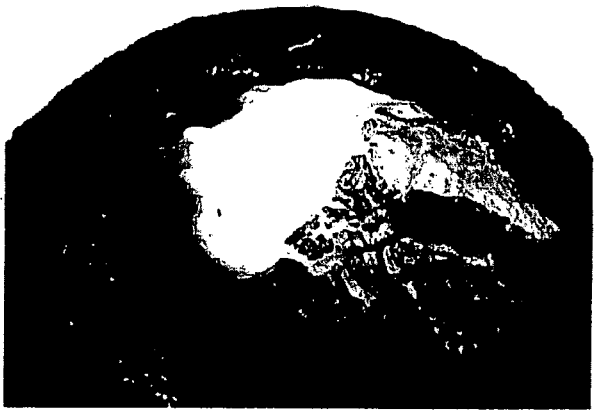


Arctic Sea Ice

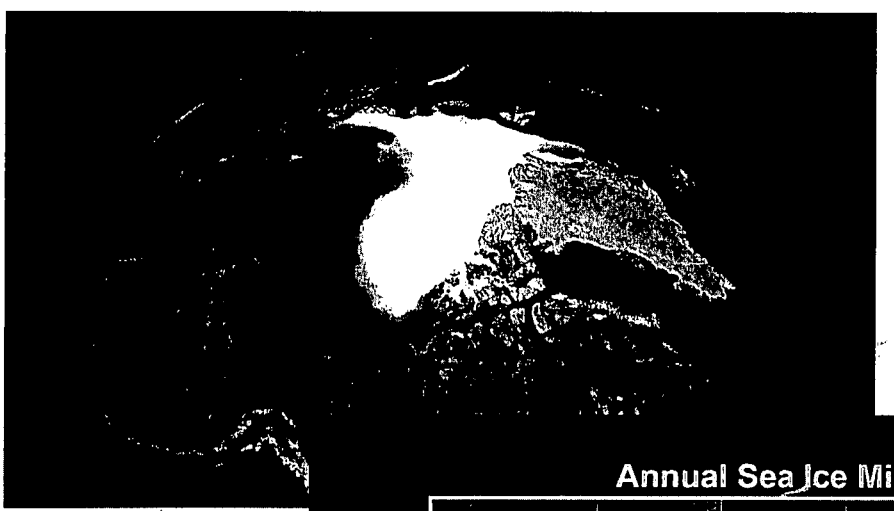
Observed Sea Ice September 1979



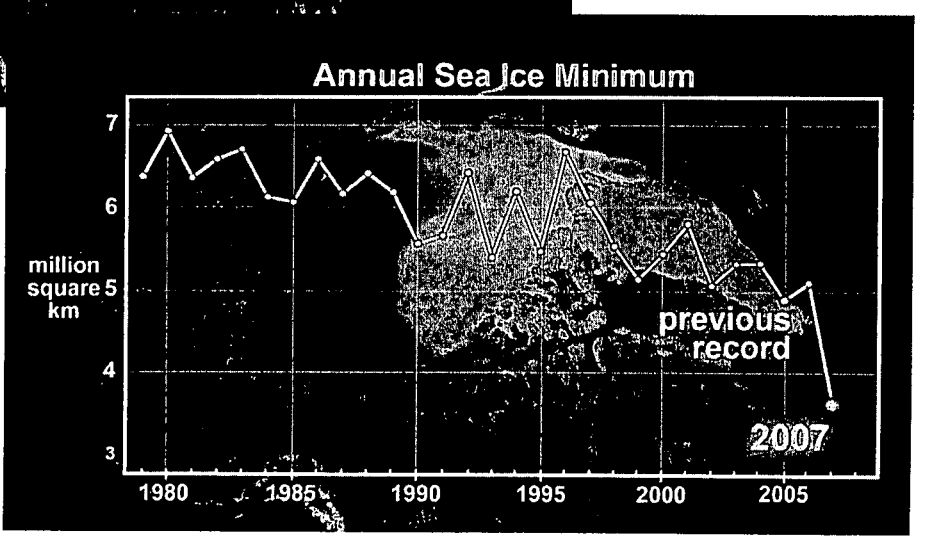
Observed Sea Ice September 2005



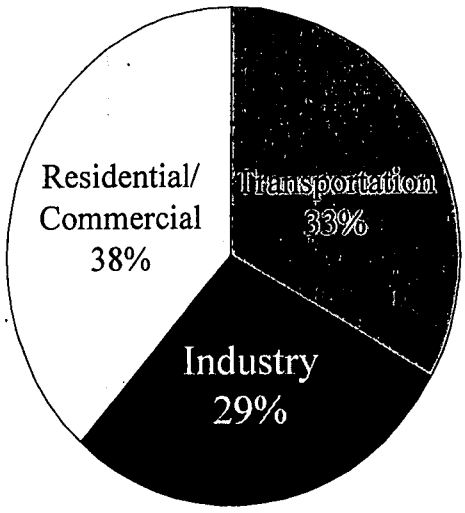
©NASA



Record ice melt in fall 2007



2002 U.S. CO_2 Emissions

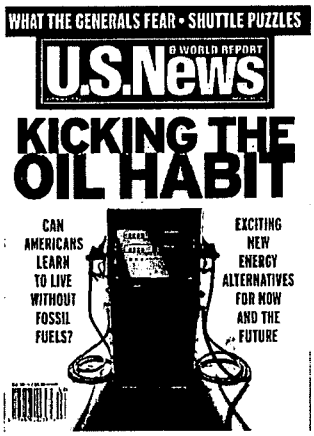


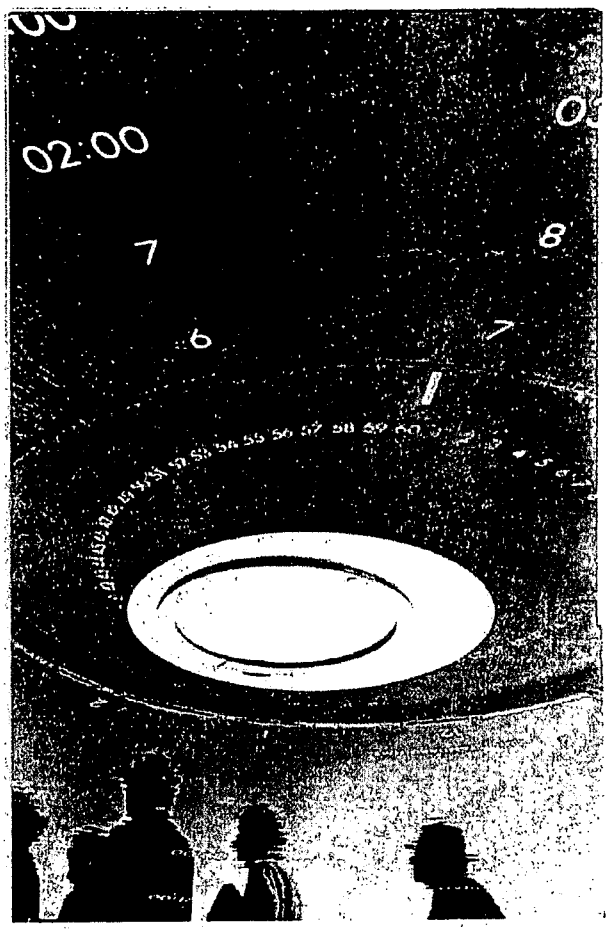
1.6 Pg C of U.S. CO_2 Emissions in 2004

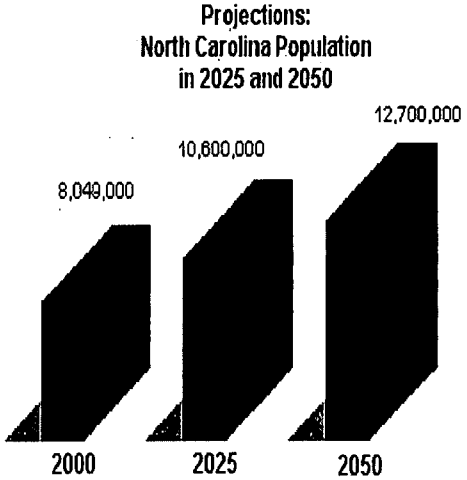
Source: DOE 2003. U.S. Carbon Dioxide Emissions from Energy Sources



Transportation: 0.6 Pg C/yr
(19% growth in the 1990s)





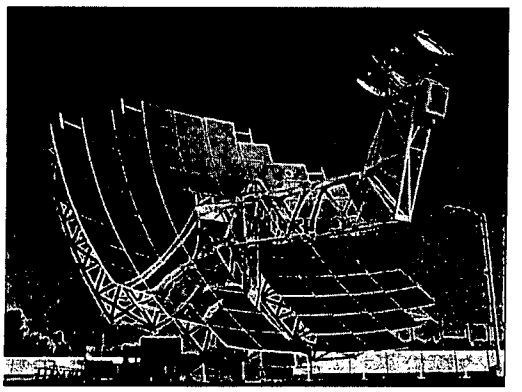


North Carolina population
in 2050:

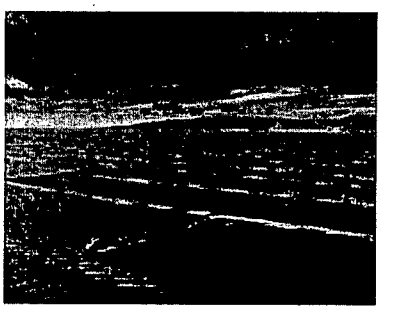
13 million people?

New "Renewable" Technologies

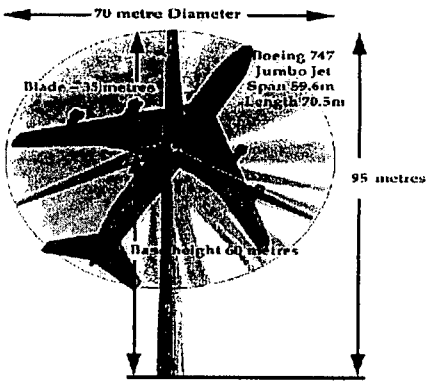
Dish Engine System



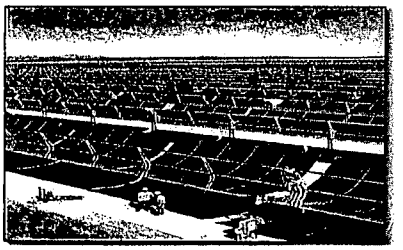
Ocean Tides



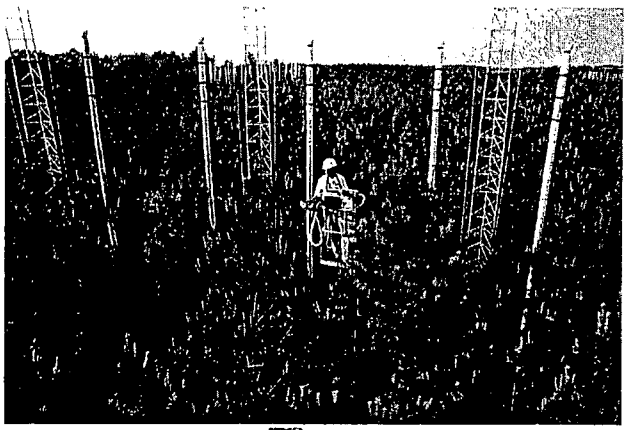
Wind

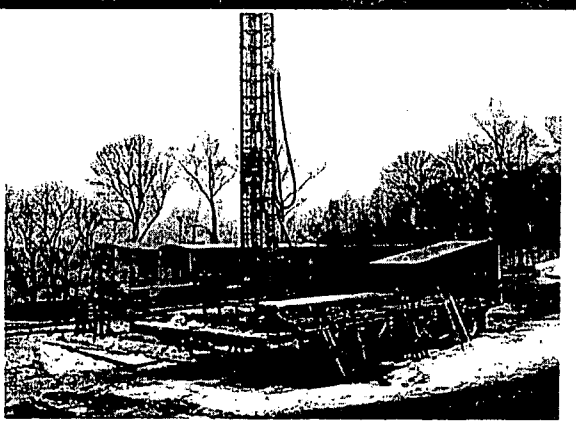


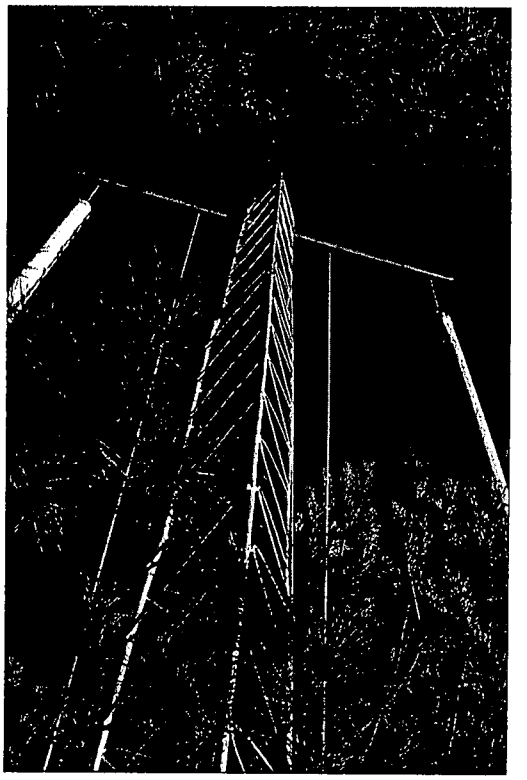
Solar Trough



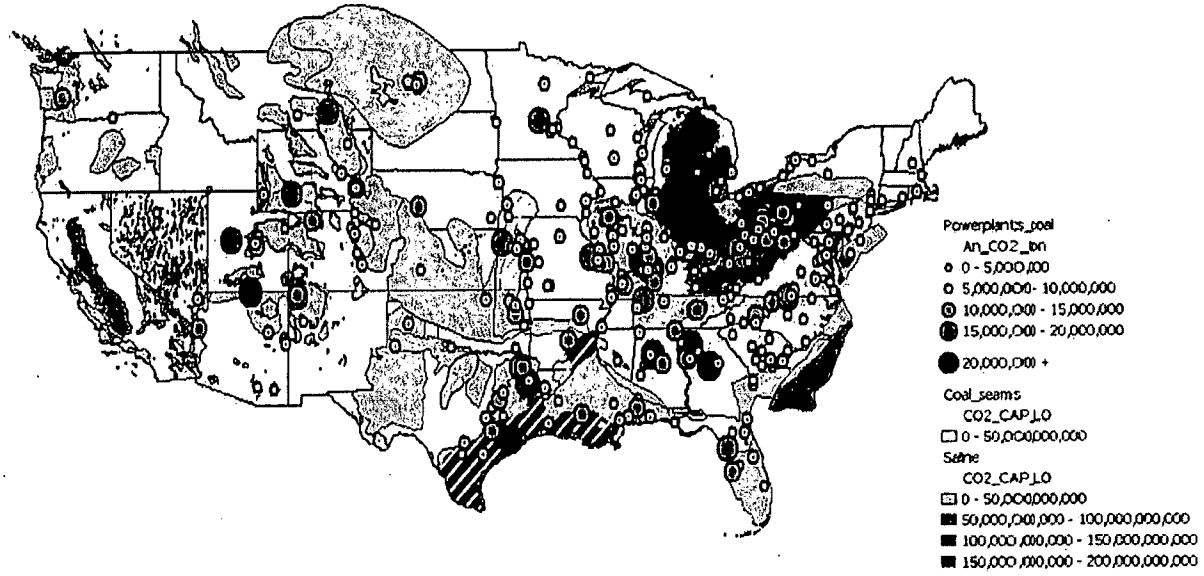
Opportunities for Land-based Carbon Sequestration







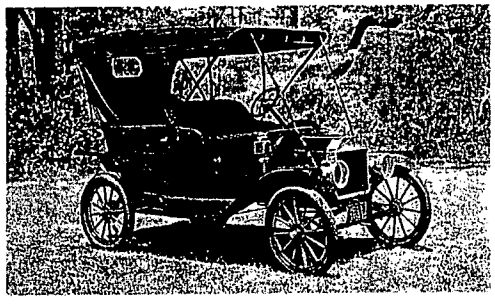
Point Sources & Reservoirs



Climate Change Policy Partnership

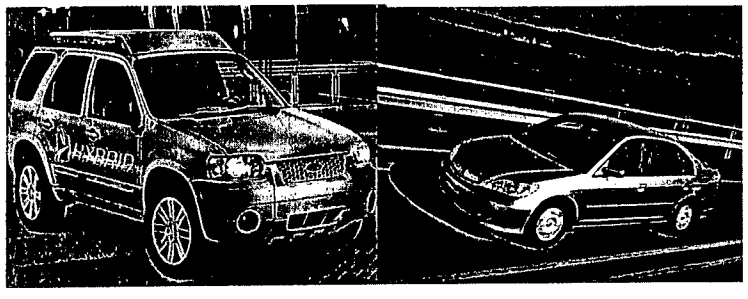
Vehicle Emission Reductions

1908 Ford Model T (~20mpg)



Today
2005 U.S. fleet average (~20 mpg)

"Tomorrow" is here
Hybrid Technology, Diesel (50 mpg)



Cut U.S. fossil fuel emissions by 10% with existing technology:
0.15 PgC/yr

Tackling Global Warming Will Improve Air Quality (regional policy)



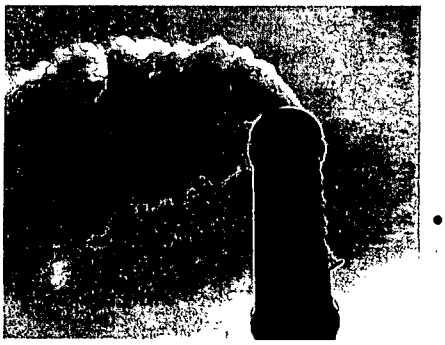


photo from NREL/PIX

- In the U.S. coal-fired power and car exhaust are the two biggest sources of the "big six": ozone, particulates, carbon monoxide, nitrogen oxides, sulfur dioxides and lead.
- During the 2003 blackout in the northeast, visibility improved by twenty-five miles. Smog and ozone pollution dropped by half within a day, and gases contributing to haze and acid rain plummeted 90%.
- Urban/regional ozone formation is highly correlated with temperature. Climate change increases temperatures on the worst ozone days as well as the number of bad ozone days



Local Opportunities

Building Efficiency

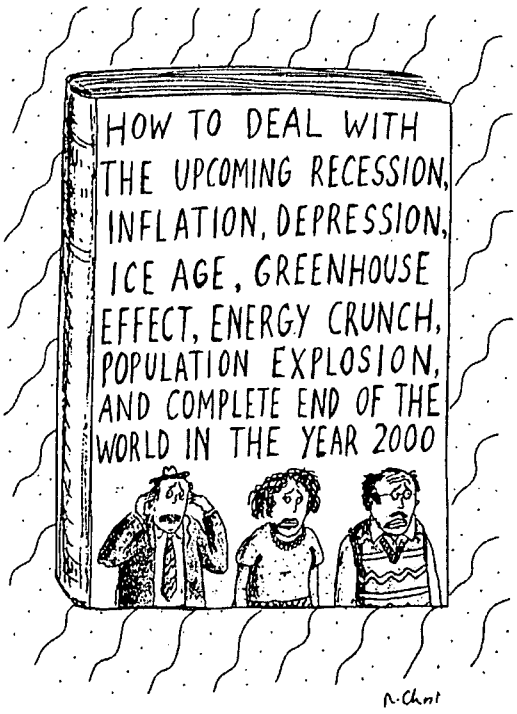
Water/Energy Savings

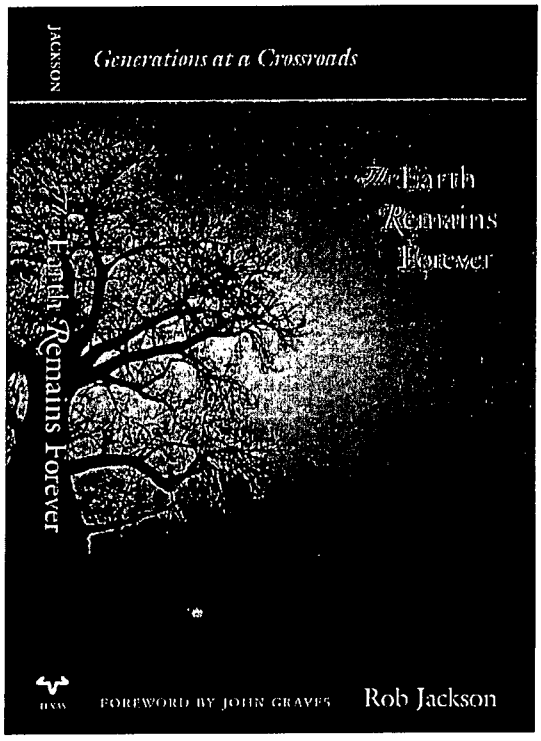
Waste Management

City Planning

Fleet Vehicles

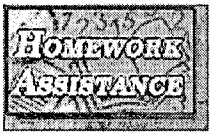
Lighting





"The world was scheduled to end today, but something must have gone wrong."
Robertson Davies, The Papers of Samuel Marchbanks.









PRINTABLE VERSION

Legislative Commission on Global Climate Change

Non-Standing Committee

DETAILS

- Meeting notices via email
- Web Site: http://www.ncleg.net/gascripts/DocumentSites/browseDocSite.asp?nID=14

MEMBERS

SENATE APPOINTMENTS

- Mr. John L. W. Garrou (Co-Chair)
- Sen. Charles Woodrow Albertson
- Sen. Janet Cowell
- Hon. Robert Miller Pittenger
- Mr. Walter Clark (Public Member)
- Dr. Delores Eggers (Public Member)
- Dr. Edward W. Erickson (Public Member)
- Mr. Tim Toben (Public Member)
- Mr. Ivan Urlaub (Public Member)

HOUSE APPOINTMENTS

- Rep. Mary Price Taylor Harrison (Co-Chair)
- Rep. Lucy T. Allen
- Rep. Becky Carney
- Rep. Charles C. Thomas
- Rep. Alice Graham Underhill
- Rep. W. A. Wilkins
- Mr. Thomas F. Cecich (Public Member)
- Mr. Robert J. Glaser (Public Member)
- Ms. Susan Tompkins (Public Member)

OTHER APPOINTMENTS

- Dr. Richard N. L. Andrews
- Ms. Caroline Choi
- Mr. Barry W. Eveland
- Dr. George T. Everett
- Mr. A. Preston Howard, Jr.
- Mr. Michael Nelson
- Mr. Mitchell A. Peele
- Dr. Daniel J. Phaneuf
- Mr. Timothy Profeta

- Dr. Sethu Raman
- Dr. Stanley R. Riggs
- Mr. Michael Shore
- Mr. Robert W. Slocum, Jr.
- Dr. Stephen A. Smith, DVM
- Mr. James H. Stephenson
- Dr. Godfrey A. Uzochukwa

North Carolina General Assembly * Legislative Building * 16 West Jones Street * Raleigh, NC 27601 * 919-733-7928

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Committee on Climate Change

Committee on Climate Change Workplan for review of the long term emissions reduction target and advice on carbon budgets

David Kennedy
Committee on Climate Change

18th April 2008

Structure of the presentation

Committee on Climate Change

1. The 2050 target
2. The first 3 budgets
3. Other issues
4. International aviation and shipping
5. Other greenhouse gases

What should the world aim to do in 2050?

Committee on Climate Change

- Scientific relationships
- Technology
- Economics

Likelihood (in %) of exceeding a temperature increase at equilibrium

	2°C	3°C	4°C	5°C	6°C	7°C
450	78	18	3	1	0	0
500	96	44	11	3	1	0
550	99	69	24	7	2	1
650	100	94	58	24	9	4
750	100	99	82	47	22	9

Judgment on unacceptable temperature change, and required emissions reductions

What should the UK contribute to global effort?

Committee on Climate Change

Take a global target, and work out the UK's share

Global target

Burden share

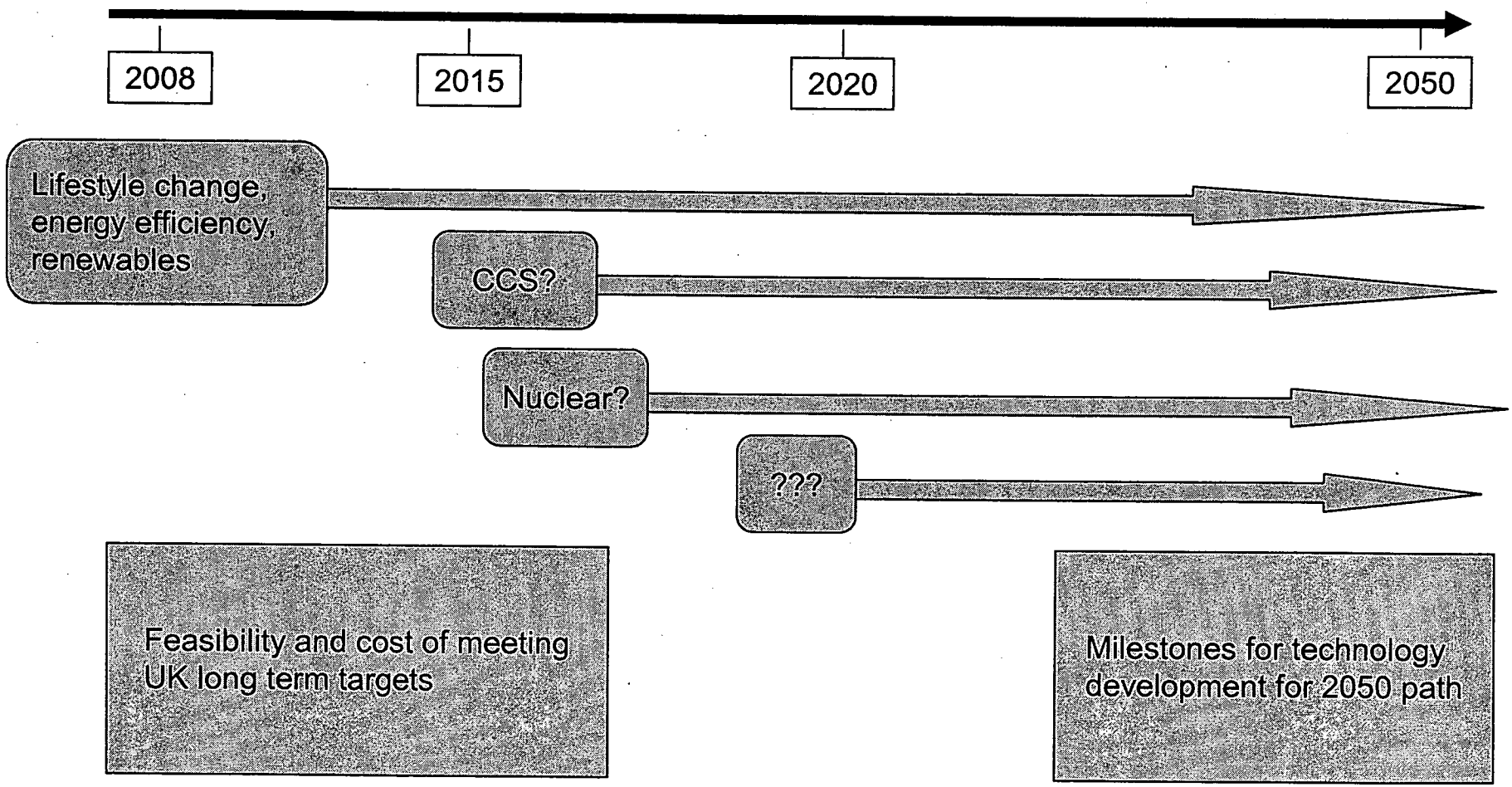
UK contribution to global effort

Current UK targets: EWP and Climate Change Bill

- *2 degrees = 550 ppm*
- *Burden share based on contract and converge*
- *60% emissions reduction by 2050*

Meeting the UK's 2050 target: the emissions reduction path

Committee on Climate Change



Structure of the presentation

Committee on Climate Change

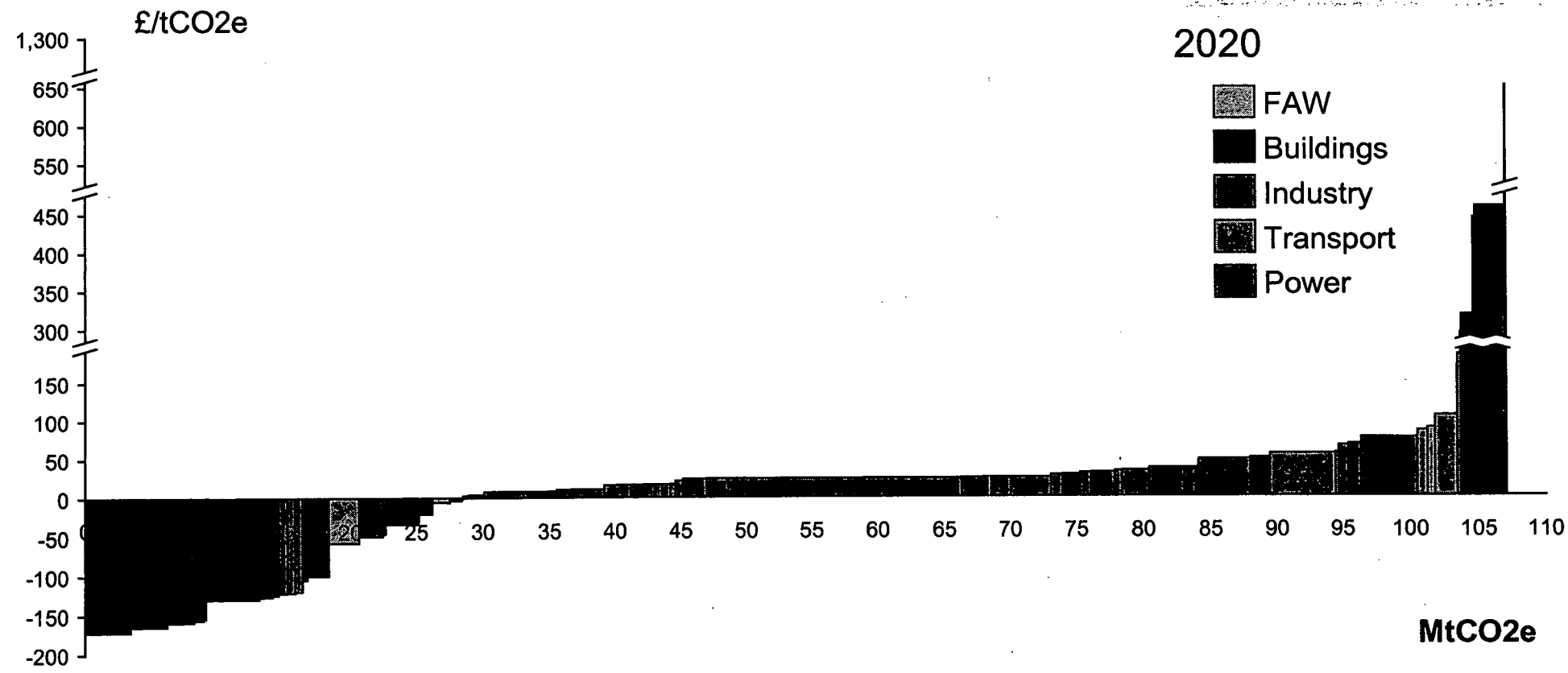
1. The 2050 target
2. The first three budget periods
3. Other considerations
4. International aviation and shipping
5. Other greenhouse gases

The level of ambition and balance of effort

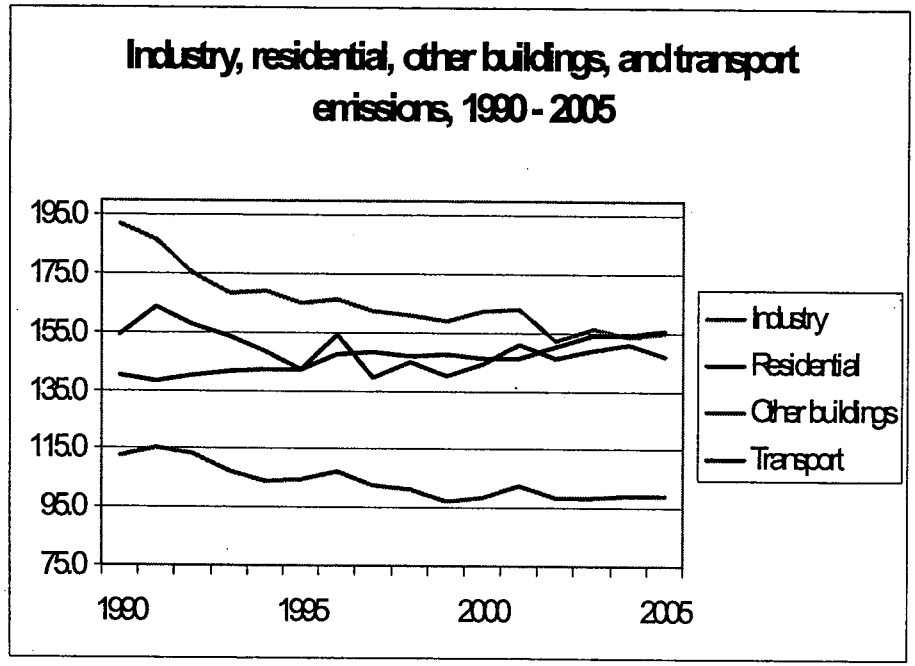
Committee on Climate Change

Factors we will consider:	Synthesis:
Consistency between 2020 and 2050	2020 target
The EU framework	Trajectory to 2020
Abatement potential and cost	
Competitiveness impacts	Balance of effort: traded / non-traded; domestic / foreign
Action in face of uncertainty	Feasibility and required policy innovation

Modelling abatement potential: an indicative UK Marginal Abatement Cost Curve (MACC)



Challenges in changing consumer behaviour



Lifestyle change

Energy efficiency improvement

Challenges in changing behaviour

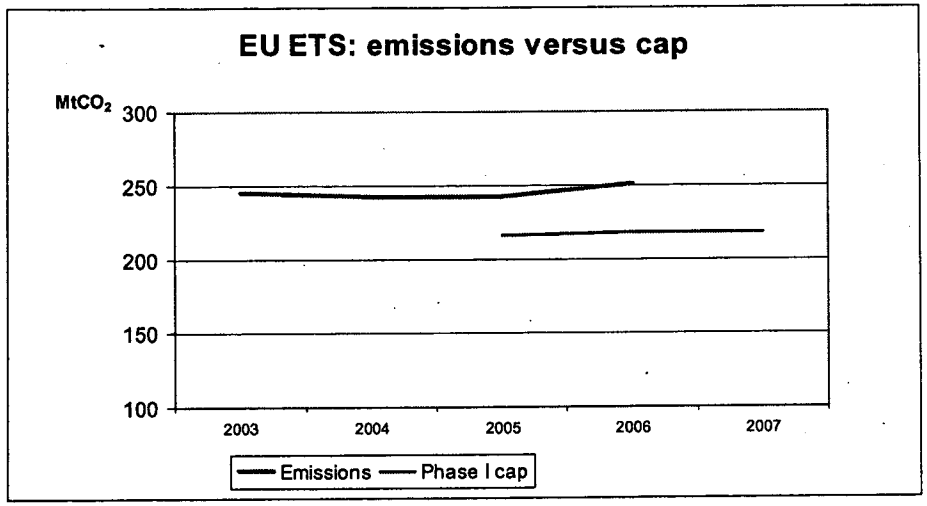
Addressing the challenges

The current framework

Assessment of realistic versus technical potential

How much should the UK rely on bought-in credits?

Committee on Climate Change



30 MtCO2 / year currently purchased from other countries via EU ETS

The CCC will consider:

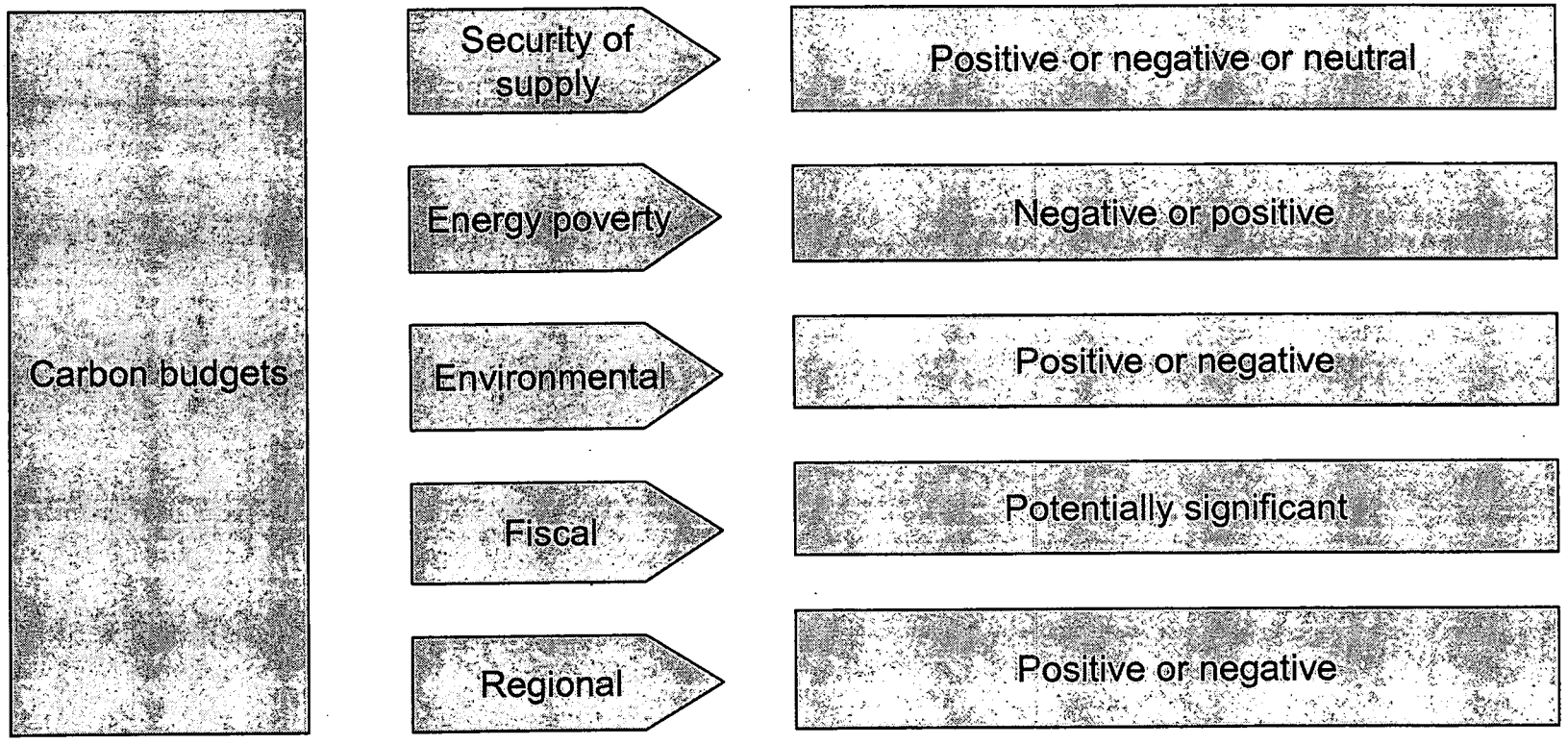
- The likely cost of credits
- Benefits for developing countries
- Technology cost reductions and demonstration effects
- Integrity of JI / CDM credits

Structure of the presentation

Committee on Climate Change

1. The 2050 target
2. The first three budget periods
3. Other issues
4. International aviation and shipping
5. Other greenhouse gases

Broader costs and benefits of UK action



We will:	Review and leverage evidence	Quantify impacts	Propose mitigating strategies

Structure of the presentation

Committee on Climate Change

1. The 2050 target
2. The first three budget periods
3. Other issues
4. International aviation and shipping
5. Other greenhouse gases

Inclusion of international aviation and shipping in the UK framework?

Committee on Climate Change

We will consider the following:

Aviation and shipping should be included somewhere in the global architecture

- Global emissions projections
- Global abatement potential in international aviation and shipping
- Global abatement potential in other sectors
- Mechanisms for reducing international aviation emissions

Conditions for inclusion *in the UK framework*:
- value added, practicality

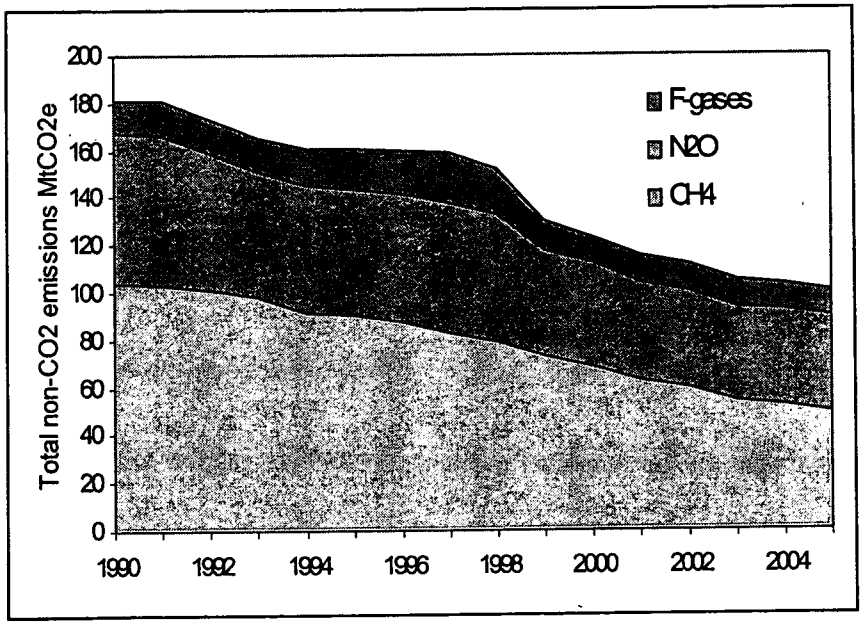
Structure of the presentation

Committee on Climate Change

1. The 2050 term target
2. The first three budget periods
3. Other issues
4. International aviation and shipping
5. Other greenhouse gases

Should our framework be expressed in terms of greenhouse gases?

Committee on Climate Change



Construct a non-CO2 MACC

Assessment of policy framework

Realistic potential and required policy innovation

Carbon budget + non CO2 budget = GHG budget

GHG budgets: are there any good reasons against?

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Joyceh@ncleg.net

MEMORANDUM

TO: **Senate Legislative Assistants**

FROM: **Joyce C. Hodge**

DATE: **January 6, 2009**

RE: **Orientation and Pre-Session Training**

Orientation to the General Assembly and computer training for Legislative Assistants, who joined the Senate Staff for the 2009 Session and during the 2008 Interim, is scheduled for next week January 13, 14, and 15, 2009. The schedule is as follows:

The Computer and Cisco phones system training will be on Tuesday, January 13 and Wednesday, January 14 beginning at 9:30 a.m. until 4:00 p.m. in the ISD Training Room on the Second Floor of the Legislative Office Building. This training is not required if you feel you do not need it.

Orientation for the new Senate and House Legislative Assistants will begin on Thursday, January 15 at 9:00 a.m. in Room1228 of the Legislative Building.

Senate Legislative Assistant Orientation will be held in the Senate Conference Room, Room 2020 Wednesday, January 21, 2009 at 9:30 a.m.

This training is for new Legislative Assistants and Assistants that have been here during the Interim that feel that they could use some classroom training. **Please let us know by e-mail if you plan to attend any of these training sessions.**

January 13; 14, 2009,	ISD Training Room, 2nd floor LOB	9:30 .am.
January 15, 2009,	Room 1228, Legislative Building	9:00 a.m.
January 21, 2009,	Senate Conference Room, Room 2023	9:30 a.m.

The Economics of Climate Change Legislation in North Carolina



Presentation to the Legislative Commission on Global Climate Change

April 22, 2008

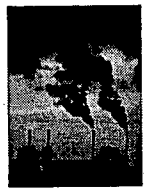
Raleigh, North Carolina

David G. Tuerck, PhD
Executive Director, The Beacon Hill Institute
Chairman & Professor of Economics
Suffolk University, Boston

1

Climate Change Policy in North Carolina

- LCGCC founded in 2005
- North Carolina Climate Action Plan Advisory Group (CAPAG) to focus on "*economic opportunities and co-benefits associated with potential climate mitigation actions*" CAPAG Background memo, February 15, 2006
- Two October 2007 Reports:
  - CAPAG Report – 56 mitigation options
  - Report on Appalachian State University (ASU) and results from North Carolina Energy Scenario Economic Impact Model (NC-ESEIM) – analysis of 31 options
- ASU report of February 2008 David Ponder, Jeffrey Tiller and Jason Hoyle, *Economic Impact Analysis of Various Climate Mitigation Options for North Carolina*, Appalachian State University Energy Center



2

My Comments Today

- Cost-Benefit Analysis: Why we need it
- Eight CAPAG Recommendations
  - CAPAG Analysis and BHI Critique
  - ASU Claims and BHI Critique
- BHI Analysis: Identification of Negative Economic Effects
  - Energy
  - Transportation
  - Cap and Trade
- Summing up: Where does that leave the case for climate change legislation?

3

Cost-Benefit Analysis: Why We Need It

- Where it came from
- What is required
- Dos and don'ts



4

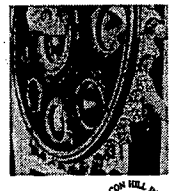
Cost-Benefit Analysis:
Where it Came From

- "Divide half a Sheet of Paper ... into two ... Columns; writing over the one Pro, and over the other Con....I have found great Advantage from this kind of Equation in what may be called Moral or Prudential Algebra." Ben Franklin, September 19, 1772
- "Each agency shall...propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation exceed its costs." Presidential Executive Order 12866, September 30, 1993

5

General Assembly of North Carolina: Charge to LCGCC

"The Commission shall conduct an in-depth examination ...[that] shall include...the costs [and benefits] of any action taken by the State to address global climate change." Session Law 2005-442.



6

Cost-Benefit Analysis:
CAPAG Report

"Joint fact finding ... will include...final benefit and cost analysis and related analysis of secondary impacts and ancillary and feasibility issues as needed." *Report*, p. A-8

7

Cost-Benefit Analysis:
What is Required?

- Benefits = dollar value of resources (labor, capital) saved or final goods (electricity) provided
- Costs = dollar value of resources used or final goods sacrificed
- Present Value of Net Benefits: greater than, less than or equal to zero?



8

Cost-Benefit Analysis:
Do's

- Do account for the capital, integration and operating costs of the projects
- Do understand what constitutes a social benefit – here the only benefit to North Carolina consists of reduced GHG emissions from North Carolina

9

Cost-Benefit Analysis: Another Do

- Do understand that, absent benefits to NC from reduced GHG emissions, the project fails a cost-benefit test
- Because net benefits are negative, a legitimate cost-benefit analysis will show net losses, not gains
- That means *fewer* jobs, *reduced* investment, *reduced* GDP

10

Cost-Benefit Analysis: Don'ts

- Don't fail to account for the goods that must be sacrificed to capture reported "savings"
- Don't use multipliers
- Don't ignore price "distortions"
- Don't count jobs as a benefit – jobs are a cost



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Cost-Benefit Analysis: On Jobs



- Job gains, a proxy for benefits but only when distortions are removed
- Job losses, a proxy for costs but only when distortions are created
- New jobs – a benefit only if they add more value than the jobs they displace

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CAPAG Recommendations:
Energy Supply and Demand

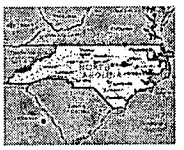
- Dedicate 1% of utility revenues to public benefits programs (energy efficiency funds)
- Environmental Portfolio Standard (EPS) of 10% by 2017 and 20% by 2020
- Dedicate 1.5% of utility revenues to demand management programs.
- Institute Public Benefits Charge on Utility Bills, $8.44 per customer



13

CAPAG Recommendations:
Transportation

- Assess vehicle surcharge on high-emission vehicles (average $7.25/car for 5.1 million cars)
- California Vehicle Emission Standard
- Bio-Fuels Bundle, replace 10% of Gasoline and 5% of Diesel by 2010, 25% and 20% by 2025



14

CAPAG Recommendations:
Cap and Trade

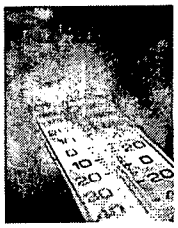
- Emissions cap of 5.8 million MMTCO2 for covered sectors/gases by 2012, declining to 1.7 MMTCO2 by 2050
- Coverage includes:
  - Facilities that use more than 5,000 tons coal/year
  - Petroleum and coal-based facilities
  - Chemical facilities that produce or import fuels that emit greenhouse gasses
- Allowance trading, borrowing and banking are permitted



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CAPAG on Benefits

"Because we do not have good information on the dollar value of GHG reduction benefits, we use physical benefits instead, measured as MMTCO2e." *Report, p. D-2*



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Cost-Benefit Analysis:
As Rendered by CAPAG

- Benefits = 0.
- Costs = energy saved, treated as a cost reduction and with a minus sign
- Net benefits = 0 – (–)Costs
- Thus, net benefits are positive



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CAPAG Findings

Recommendation	GHG Reduction (MMtCO2e)	NPV of Cost Change ($ million)
Energy Supply and Demand Proposals	322.5	- 2,502.2
Transportation Proposals	95.6	- 3,490.0
Cap and Trade Proposal	47.4	284.0
Total	465.5	- 5,708.2

Report, pp.I-12 – I-14, G-1

18

BHI Critique

- Energy:
  - If the private benefits are really so large, why are consumers not taking advantage of them already?
- Transportation:
  - Vehicle surcharges: $37 million of additional spending per year will generate more than $860 million per year in savings – a return of 2,300%!
  - Tailpipe standards: If vehicle upgrades save on fuels, why don't drivers demand the upgrades?
- Cap and Trade: Underestimates cost



19

ASU Claims, October 2007

- Increase employment in the state by about 23,500 annually – 325,000 new jobs by 2020, 8% of the current number of jobs or 61% of existing manufacturing jobs
- By 2020:
  - Boost income by over $14 billion
  - Raise Gross State Product (GSP) by $20.67 billion



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ASU Claims, February 2008

- One example:
  - Renewable Energy Production Subsidy – incentives of $0.005 per KWh of electricity
  - Renewable Portfolio Standard – 12.5% of electricity sales from renewable sources
  - Biomass Production subsidy – $1.27/MMBtu
- Economic "benefits" – in 2020:
  - 4,750 jobs
  - $268 million in income
  - $447 GSP
- Why not double all the incentives - $0.010 per KWh, 25% of electricity sales, $2.54MMBtu? Why not quadruple the incentives?
- Why not double or quadruple the benefits?

21

Moral

- GHG mitigation is a conceivably valuable goal
- But these proposals would induce consumers and producers into substituting less efficient for more efficient ways of consuming and producing
- The result will be job, income and production losses, not gains

22

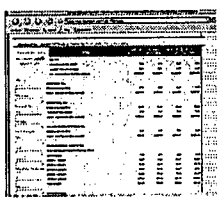
One ASU Economist on ASU Findings

"Using a simple supply and demand analysis, ... renewable energy forcing will increase the costs of production....The increased production costs will decrease the supply of goods and services and prices will rise." John Whitehead, "Climate Policy is Not Likely to Increase Jobs," posted on http://www.env-econ.net/2007/10/climate-policy-.html, October 24, 2007

23

BHI Analysis of Economic Impacts

- State Tax Analysis Modeling Program (STAMP) used to estimate the effects of proposals to reduce greenhouse gas emissions
- Inputs. Changes in: tax rates and, government spending, energy and transportation costs
- Outputs. Changes in: employment, investment, state fiscal stance, wage rates and capital stock compared to the baseline of no changes



24

Energy Impacts

($ millions)

Variable	2011
Net Employment (Number of Jobs)	-2,473
Investment	-76.7
Real Disposable Income	-242.5
Real State GSP	-360.3
State and Local Revenue	170.3

25

Transportation Impacts

($ millions)

Variable	2011
Net Employment (Number of Jobs)	-1,202
Investment	-27.7
Real Disposable Income	-46.5
Real State GSP	-168.0
State and Local Revenue	-17.5

26

Cap and Trade Impacts

($ millions)

Variable	2011
Total Employment (Number of Jobs)	-29,808
Investment	-397.9
Real Disposable Income	-1,976.5
Real GSP	-4,002.6
State and Local Revenue)	-337.3

27

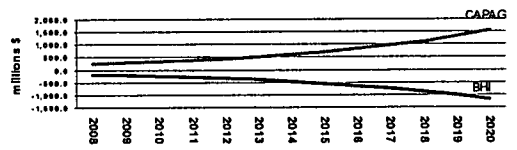
Total Impacts

($ millions)

Variable	2011
Total Employment (Number Jobs)	-33,483
Investment	-502.4
Real Disposable Income	-2,265.5
Real GSP	-4,530.9
State and Local Revenue	-184.6

28

Net Benefits of Energy and Transportation Proposals: CAPAG v. BHI



29

Where Does That Leave Us?

- Proposed legislation may provide benefits but they have yet to be determined
- The legislation would impose measurable costs on business and on the economy
- Commission should
  - weigh these costs against the purported (and so far unsubstantiated) benefits
  - consider the effects on competitiveness



30

The Beacon Hill Institute at Suffolk University

The Beacon Hill Institute at Suffolk University in Boston focuses on federal, state and local economic policies as they affect citizens and businesses. The institute conducts research and educational programs to provide timely, concise and readable analyses that help voters, policymakers and opinion leaders understand today's leading public policy issues.

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31

Legislative Commission on Global Climate Change
November 14, 2008
643 Legislative Office Building
Minutes

Representative Harrison called meeting to order at 10:15 a.m., stated that Mr. Garrou would not be present and welcomed everyone. She also state that Mr. Michael Regan was replacing Ms. Jane Preyer and Mr. Dan Crawford is replacing Mr. Michael Nelson. Members present include: Representative Harrison, Co-chair, Senator Albertson, Representative Underhill, Dr. Eggers, Mr. Tim Toben, Ms. Susan Tompkins, Mr. George Everett, Mr. Dan Crawford, Dr. Stanley Riggs, Mr. Michael Regan, Mr. Robert Slocum, Dr. Stephen Smith, Mr. James Stephenson, Ms. Caroline Choi, Mr. Mitchell Peele, Mr. Ivan Urlaub, Mr. Robert Glaser, and Dr. Pete Andrews. The visitor registration is attached as Exhibit A. The agenda is attached as Exhibit B. Representative Harrison called on Mr. Givens for remarks.

Mr. Givens: He thanked everyone for coming and stated that our analyst for environmental issues is on maternity leave she had a little girl and if you want more details our other Jennifer will be happy to provide that. She expects to come back at least part-time in December and I am doing my best to hold her to that.

We have a new clerk today, Patsy Etheridge who replaces Anne Misenheimer and we continue with our clerk Thelma Utley who has been with us almost since the beginning and we appreciate her loyalty and I think you know the rest of us up here.

There are several documents that have been or will be distributed – I call your attention to this document (has it come around yet) Ivan Urlaub brings this North Carolina Renewable Energy and Energy Efficiency Industry Census 2008 (EXHIBIT C) and we will enter that into the record.

Tom Peterson who has been the Department of Environment and Natural Resource's contact for the Climate Action Plan Advisory Group (CAPAG) process has sent three documents that are being distributed and one that is being referenced but because of its volume we did not print. The first one is a memo to the Commission and copies to myself and Brock Nicholson (EXHIBIT D) summarizing the activity of the CAPAG and referencing the completion of its work. The other two documents relate to criticism of the Appalachian State University Economic Analysis. There is a Peer Review (EXHIBIT E) of the work of David C. Tuerck who presented to the Commission I think at our last meeting before the interim was recessed in May. There is also a document captioned on letterhead from the Florida Department of Environmental Protection (EXHIBIT F). Apparently there is an institute in Florida called the James Madison Institute, which I gather is an analog of the John Locke Foundation and that information is supplied by Mr. Peterson and following our usual practice we've distributed all of that for the records.

The Co-chairs and counsel have met and discussed what we want to do in the very short time we have in this short interim and it is our hope that we will transition at this meeting from presentations about various topics and on to a serious examination of possible

recommendations. Chairman Garrou in his subsequent conversations has advised me that we must now consider the direst of situations with the state budget and what the extent to which there will be funds available to do various things and the extent to which additional burdens can be placed on the private sector.

What I would like to do – I had originally thought I might do at this point – but I have decided to provide you with some additional information that will be printed so I would like to come back Madam Chairman at a later point in the agenda and talk in further detail about how we intend to proceed with the recommendations process. So with that I would ask this question, Chairman Harrison indicated we had two changes in membership and I think that that is all but is there anybody else who is here as a designee of an appointed authority who is different from what we had before.

Today's agenda, I think it is a good one – we have timed it out for about three hours. Of course that depends upon the number of questions that are asked but we did not schedule a lunch break. The first presentation is from a new source for us, the one that Chairman Harrison and I are much involved in. I have been appointed as the staff chair for the National Conference of Environmental Legislative Committee on Environment and Chairman Harrison is the Vice-chair of that committee. The National Conference of State Legislatures (NCSL) has published a number of reports on climate change and Mr. Anderson is going to talk to us about those reports and the outcome of the trends that he has seen from the perspective of the organization of state legislatures nationally including the most recent snapshot of what is going on with the State. We will also hear the presentation from the Southern Alliance for Clean Energy (SACE). Steve Smith has asked to make a brief introduction of Mr. Wilson so with the indulgence of the Chair when we get to that we will do that. The remaining presentations that are listed on the back of the agenda are as I indicated with regard to adaptation matters many of you have expressed an interest in going forward with that.

I note the schedule of meeting on the agenda and I think probably we need to revise that a little bit. I am going to ask Ms. Matheson to look at that because I think we have two meetings in January and I am not sure that the 13th is the last one. We have scheduled two in January so that we would hopefully have time to get our recommendations together in time for the long session. We will look at that and get back to you on it – don't leave without knowing when the next meeting is. I apologize that the back of the agenda is incorrect.

We have two meetings scheduled - January 13th that is correct, we scheduled an additional meeting for January 27th – that I believe is a Tuesday and that is the day before the Legislature convenes. So we are going to try to wedge another one in and we will have two in January and we will assimilate a written notice to that. I think that is all for the moment Madam Chairman.

Representative Harrison: Thank you – minutes?

Mr. Givens: With regard to the minutes – thank you – we have dissimulated to you draft minutes for all of the meetings (EXHIBIT G) for which we have not previously submitted minutes except the last one before the session, which was 22 April. That one is in progress

– if anyone is prepared to offer a motion to approve them at this point that will be fine. If you want to take them home and read them, we will put them back on the agenda for December and you can offer any corrections that you want at the pleasure of Chair and the members.

Representative Harrison: We will proceed with our first agenda item. Glen Anderson is here with us from NCSL. Thank you for making the journey to North Carolina.

Mr. Glen Anderson: Hi my name is Glen Anderson with NCSL and I am happy to be here with you today. NCSL has been working on climate change issues and renewable energy issues for a number of years now and my focus and NCSL is climate change and renewable energy and we've recently published 12 publications that are exploring the cost of climate change in various states. This is regardless of any type of mitigation to some extent that is done since there is likely to be some type of cost regardless of whether zero emissions or significant reductions in emissions is achieved or not since we are already locked into a certain degree of warming.

Now I want to cover a number of things here basically the potential economic impacts of climate change for North Carolina and what are some of the costs that have been forecast with regards to greenhouse gas reduction policies. Also offer an update of the latest developments in state climate change policy and review how the federal climate policies may affect the state policy landscape.

Representative Underhill: The studies that you mentioned from NCSL have they been sent out or do we need to request them?

Mr. Anderson: We worked with the University of Maryland to produce these papers. Essentially they did the brunt of the scientific research, we also produced some over view information on the science of climate change and we also did the policy options part not really recommendations but more what type of options there are. Those are all published and on our web site. We have the North Carolina ones, I brought copies (EXHIBITS I, J) of that but hopefully each of you will get that as well. But we have nice color pdf's on our web site as well and all 12 states are accessible. It's a crutch I know for presenters who don't know their topic well enough, but that's really not the case here. It's really for your information but I do have a few charts and drafts that could be pretty helpful.

But in any case, the University of Maryland did much of the scientific research. We took that and put it in an understandable format and kind of refined it a bit and then we did that for 12 states. The reason that we chose those 12 was because of the geographic representation of states which were not just geographic but also population wise and also to the extent that they represented diverse economic bases throughout the nation since many of them will be seeing different impacts based on what their economic structure is and their geographical location. Part of the reason we wanted to do this was since there has been multiple forecast on the cost that greenhouse gas productions may cause the economy particular with the regards to the number of the bills that have been introduced in Congress. However few studies have really explored the economic cost of climate change so we, as I said, partnered with the University of Maryland, they have a center for Integrated

Environmental Research and have been leading in this area and a regional research was reported about a year and a half ago. So we built up that and in addition they ran some economic models that for each state, there is a number of research institutions that have developed these economic models that are able to look at different impacts and the agricultural sector in a state. How much of an impact will that have on the rest of the economic entities within the state – so how it would feedback and if the employment for instance and other transportation essentially those other economic grounds? With that there is a predicted four degree increase by 2100 for the southeastern U.S. and that is something that actually has been established by NASA and is in agreement with the Intergovernmental Panel on Climate Change (IPCC) research as well. The predictions are 7-23 in. global rise in sea-level and the reason there is such a great disparity there is different regions will see different rise depending on where they are within the globe. There is also quite a bit of range depending on how much warming we see and what type of feedback mechanisms might occur to what extent there might be melting and how much the ocean will expand. In fact most of the rise in sea-level is caused by the expansion of water as it warms not due to the melting of ice.

For North Carolina more than half of the state's shorelines are considered to be at very high risks according to the U.S. Geological Society and there is a potential for increase in severe storms and flooding for North Carolina. As well there are agricultural impacts on productivity due to increased temperatures that decreases productivity for animal reproduction and also for dairy production as well. Coastal infrastructure and drinking water supplies may also be at risk. This is just a map produced, in addition, I am not sure if where, but the coastline in North Carolina is subsiding at about seven inches per 100 years. So that compounds the increase that adds to the increase in sea-levels. So that is important to keep in mind as well. The dark red areas in this map demonstrate those areas that are highest risk, so the lowest line levels and the lighter areas demonstrate those that are at risk from higher sea-level increases. So according to the U.S. Geological actual survey more than half of the coast line falls in this highest risk area and as you can see there that is about 2,000 sq. miles. The middle risk and the low risk areas add another 2500 sq. miles to those risk laden areas. Under the 18 inch sea-level rise scenario which is considered a mid range target for increase in sea-level losses to North Carolina by 2080 have been estimated at around 10 billion dollars.

This is a break down of four different coastal counties and the estimate by 2080 under the 18 inch sea-level rise scenario and the total cost would be about, for these four counties alone, would be about 2.8 billion dollars and you can see how there is a significant loss both in residential property and non residential property values. This research comes from the National Commission on Energy Policy and it is from 2007. In addition, there have definitely been a number of studies and a number of climatologists that have modeling forecast increasing in hurricane and severe weather. I know that some, particularly in Colorado, there is a fairly well known researcher that has disputed whether hurricane incidence will increase. However base physical modeling indicates that when there is an increase in energy within a system that provides just a larger amount of energy that is available from storm systems. However, there are so many other variables included that it is hard to predict however, most of the research now indicates that there is likely to be a tendency towards more severe weather and an increase in the severity of hurricanes as

well. As an example, just of the potential costs, North Carolina agriculture suffered about 2.4 billion dollars in losses in the decade between 1996 and 2006 from 14 different hurricanes and Hurricane Fran caused 1.7 billion in forest damages. And the forest sector generates about 3 billion a year for North Carolina, so it is a fairly important sector; so that is important to keep in mind.

There are also potential costs to public health, North Carolina as you know, sections such as the Charlotte metropolitan area have some of the highest ozone levels and the chemical reactions that take place to create ozone from, for instance auto emissions or industrial emissions, that chemical reaction accelerates with higher temperatures. So that is why some of the worst temperature or highest temperature days also tend to be the most polluted days. If you notice some of the ozone alerts tend to be on much hotter days. An increase of say four degrees in the southeast here could or is likely to increase the amount of ozone. However, there is a number that is not necessarily taking into account the Clean Air Act and what type of clean energy policies might be pursued. There is also high incidence of asthma and other respiratory diseases in this region and those are definitely worsened by ozone and there is some research that indicates that high ozone levels and smog levels actually cause asthma. So as to regards to water, increased temperatures may increase the incidence of drought there is forecast to be actually an increase in the amount of precipitation, however, that precipitation is predicted to come in more extreme cases. So there may be a larger total amount of water however, it may not come in smaller rainfall events but more in very large rainfall events and with higher temperatures that accelerates evaporation and is likely to cause the land to dry out more quickly and higher amounts of rainfall will lead to more flooding when it hits the dry land. And that can wash off, for instance, pollutants into water bodies and threaten water fall to increase the cost of cleaning the water as well or water treatment.

In summary, North Carolina faces large, this is just for the North Carolina section here, challenges in adapting to climate change lying at the coastline. Some level of sea-level rise is inevitable since I believe that even if the most extreme carbon dioxide (CO_2) reduction is about 80 percent by 2050. If we do achieve that type of reduction in emissions then globally we are still locked into a two and a half to three degree Fahrenheit global temperature rise which will cause some significant changes. More research on the impact of climate change on coastal development on fresh water development on fresh water supplies, flooding and agriculture is needed. Really one of the things that we discovered through during these reports is there is very little information available on this issue and part of that is just because the models are not yet able to go down to the state level the smaller regions. They can go down to the regional level but right now they have not yet been refined enough to go down to the smaller regional levels. Also, there just has not been as much interest in doing research on this and I think that they're starting to grow but definitely as a place that needs to be explored more.

In addition to adapting to some things that may be considered as adapting coastal management plans as well as habitat protection plans and emergency response plans to take into account these changes in the future may be an option, maybe useful as well. Are there any questions on that particular section? I have kind of like three components of this presentation so if there are any questions, I can answer those now. Yes.

Dr. Riggs: Not a question, but a comment. We are already at the upper levels of sea-level rise in northeastern North Carolina, we will not be there in 2100, we are there now and the impact is that there is a large group of people working on most of these problems in the State here. We have a very active research group going on and there will be several presentations later today and next session that will give some of that information.

Mr. Anderson: Great, great – I think possibly when we did this research and almost a year ago I think there was a lot that was being done but we hadn't seen the results of evidence of the research at that point.

The next section I wanted to focus on some of them have been forecast by a group called the McKinsey Group and they are a global management consulting firm that have done quite a bit of research by gathering together industry experts, large companies and academics to break down the many different components or many different ways in which greenhouse gas emissions can be reduced throughout various sectors of the economy. This first graph here is the Energy Information Administration forecast on emissions levels by the year 2030, so they are forecasting almost a 30 percent increase mostly driven by the growth of the U.S. economy and the growth and population and above average growth in buildings and appliances and the increase in coal fired power generation that is likely to be needed to essentially supply a mass of growth, approximately 30, it is actually from what I have read, 25-30 percent growth in energy demand by that time, that is business as usual. So without any extreme greenhouse gas reduction policies this graph I think is... Go ahead.

Representative Harrison: Could I get a clarification – is that 35 percent growth from 2005 levels or 1990 or what?

Mr. Anderson: Yes, that is 2007 I think that was 2005 levels actually for 20-30. So they forecast for 35 percent. Of course they don't take into account uncertain policies that have not been passed yet. So that took into account those policies that had already been enacted by that time. I think this part is interesting in that it reflects with regards to electricity consumption that is different components of U.S. post residential and industrial electricity consumption and how they have grown since 1977. So it is four decades from 1977 and you will notice that it's been actually reduction in safe heating, increasing space cooling and water heating and refrigeration has not grown much at all. And that also reflects the total consumption so regardless of population growth that really shows that there has been dramatic increases in efficiency particularly for refrigeration – we cut the actual per capita consumption for refrigeration by almost fifty percent. There have been great increases in energy efficiency to offset some of the growth and electricity consumption, however, when it comes to the other categories that now make up 43 percent of the total. That comprises all of the new electronic gadgets such as computers and plasma televisions and multiple televisions and other types of devices that have become comic throughout the U.S. and there is forecast that is going to continue to grow, there will be all sorts of new appliances and electronics here that is likely to be purchased by consumers. So really we have made tremendous advances when it comes to that – energy efficiency however, this growth of the other category is something that is somewhat concerning.

Now this next chart I am not sure if many of you have seen it, this is the chart that was compiled by the McKinsey Group and I think it quite interesting in the fact that it vindicates how many different and desperate areas of the economy could be addressed to reduce greenhouse gas emissions and that there is not just one single kind of silver bullet, there are many silver bb's, to steal someone else's quote. I think that one of the largest areas of reduction is actually at the right and this shows abatement cost, all of these little sections from fuel economy back to distributed solar TV – all are less than $50 per ton of CO_2. So they only went up to about what would be three gigatons of reduction and most of the bills that have appeared on the Senate floor are looking at about 4.5 gigatons or up to 5. That is what I think has been seen as necessary to really need the stabilization of three degrees in global temperatures. So this isn't going quite that far but yet it is quite telling in that it shows that that amount of the CO_2 reductions can be gained at negative margin cost and that is costs that are below zero. They will actually pay back for those industries that engage in mostly energy efficiency practices. Although not all of them are but again the largest contributor here is only 11 percent of the total and that would be putting carbon capture in sequestration on coal fired power plants and that actually falls into a fairly high level with regards to cost. Looks like about 50 to 60 dollars per ton.

The next slide just highlights the energy efficiency components and how much can be achieved through energy efficiency. Nearly 40 percent of the total reductions could be achieved through energy efficiency and negative marginal costs. Meaning that there would be no cost to society and perhaps an economic benefit. The interesting questions one might have is why these aren't being pursued already and I think for many of you, you may have heard some presentations on this issue of there's a number of market barriers to energy efficiency in the fact that in many cases the person who benefit from energy efficiency may not be the entity that pays for it or institutes it. For instance, a building – the person that built the building they have to have a lot higher expertise and it may cost them slightly more, though not much more, but they are very competitive in the building market and housing market. It might cost slightly more and yet the consumer that purchases the building may not pay enough more for the builder to feel like they are getting compensated appropriately. Therefore, the benefits really go the owner and not the builder and that is one of the main problems actually the main market barriers. There are many others as well but this is one of the main market barriers for energy efficiency. This chart also includes what is called hard wire and energy efficiency not consumer behavior and the significant amount can be achieved through behavioral conservation. However, that is not cleared at all in any of these estimates.

One of the other interesting components of energy efficiency is that a number of states, Minnesota for example, has an energy efficiency requirement, a standard for their utilities, particularly it could sell energy for example as required to meet 1.5 percent of their total energy demand each year through energy efficiency. Their growth actually in energy demand is around 1.5 percent, so that means they are meeting almost all growth and energy through energy efficiency. So they just don't need to actually build new generations. That is the same assessment that McKinsey found was that almost all growth can be met through energy efficiency measures, mainly in buildings. That in and of itself is important in that than the other types of operatives if you can actually stop the growth in energy

demand and then there can be some fuel shifting or displacement of certain types of positive carbon intensive fuels to non carbon intensive fuels that take a significant chunk of the problem out of the way. However, I think it is important to know that keeping energy efficiency targets will take pretty aggressive policy measures to overcome a number of the market barriers and some of those also deal with long pay back on cost as well. So what types of return do investors receive on investing in energy efficiency? There are a lot of different policy approaches that different states have taken such as Delaware, which has sustainable energy utility which the utility itself actually sells since we use this energy efficiency instead of just using it as a supplemental type of demand reduction resource uses it as a supply resource. So it naturally competes on the market instead of, for instance, building new generation you can build new energy efficiency which reduces the need for new generations which is potentially the same as building a new generation. So there are actually quite a few different policies which have been explored straight up policies across the U.S. to remedy some of the market variables.

Now I am going to go into the federal versus the state policy conflict with regards to greenhouse gas reduction. First off, I just wanted to present some of the arguments that have been presented for the federal folks. I know that a number of states are interested in the federal approach as well. However, the pre-exemption issue and the ability for them to set their own levels above a certain baseline have been perceived as quite important. Some of those arguments including fuel emission standards should be federal since these laws are subject to federal regulations and pre-emption with the exception of California which can set its own emissions standard and apparently has been able to do that. I will speak to that issue a bit later. In addition, economists argue that a national market for carbon credits will be the most efficient way for carbon emission reductions to be reached. Since the larger the market, the less inefficiency there supposedly is and also it allows those players within various sectors where it may be quite expensive to be able to pursue the purchase of credits and those that are most efficient and able to reduce their carbon emissions at least cost and then sell those credits. In creating a larger market just allows a larger number of players which apparently reduce cost for the economists.

In addition, it allows a level playing field for citizens with businesses and that argument is that a password for various state regulations makes it very challenging and much more expensive for businesses to play in this arena and also addresses the need for coherent and comprehensive national and international actions. With regard to the state side of the argument most greenhouse gas and emission reductions come at the state level and under the jurisdiction of state laws currently. In addition states generally are best prepared to understand which policies are most effective and have varied resources, different states obviously have different types of renewable resources, different types of carbon rich resources and are best prepared to be enlarged and how they can utilize those resources to achieve goals. The current Clean Air Act while the Environmental Protection Agency (EPA) does administer it, it allows the state or essentially gives the power to the state to meet the goals in what ways they see fit. So that is another argument. These are just some of the different policy situations that have been looked at or whether more of the power is given or centered around the federal administration versus state administration. Federal law could, for instance set emissions levels and deadlines allowing states to design the necessary policies. Federal law could regulate sectors equally and have a rate of reduction at a rate of

six. That would mean that the states had little ability and little flexibility but had to just meet different sectored reductions. That would mean they would not have the ability to use carbon offsets or carbon sequestration or a combination of those options which some analyst have seen as being the most likely. However, recent federal climate bills have not really provided much for the states with regards to implementation as it really left it up to EPA for administering. So it would be up to EPA to decide how they would administer that. In addition, the things that have been introduced in Congress which are really cap and trade focused kind of favor the federal government when it comes to distribution on the sells of credit. So it could be billions and billions of dollars of resources gathered through the sale of these credits and whether the state gets the money and use it for their implementation or whether the federal government gets it is a definitely a sticking point there.

How much time do I have? I will skip this section here and we will just go into the states. I was going to cover a little bit about the carbon tax and cap and trade but...

Representative Harrison: That might be good actually.

Mr. Anderson: Would you guys like to hear that? OK. It is really just a short summary since I think carbon tax has been discussed but the details of it really haven't been explored much and it has been seen as a politically unfeasible approach since it seems that all are adverse to new taxes and there are many strong powerful players that seem to be against any type of carbon tax. So just as to what it is, it is a direct fee on CO_2 emissions which is raised over time until the goal is reached. So the producer would be taxed, for instance, the coal fired powered plant, or the natural gas fired powered plant or any power plants for that matter that generates CO_2 would be taxed and then they would in turn raise their rates to recoup that fuel increase and consumer would pay increased prices. It is widely supported by economists, perceived as easy to understand and transparent and currently operating in five countries and two U.S. cities, one being Boulder, CO and the countries are Finland, Sweden, Great Brittan, New Zealand, and Canada. Both Quebec and British Columbia have implemented some type of carbon tax. San Francisco has also implemented one as has (inaudible) recently has as well.

So with regards to the pros and cons for both the carbon tax and a cap and trade there are a number of pros and cons and I think that it comes down to there are different ways to design any program and I think you can design a good cap and trade program or a bad cap and trade program and certainly you can design a good carbon tax and a bad carbon tax, one that is ineffective. As to the pros it can be seen as a revenue neutral carbon tax, that is one of the options which means that taxes in other sectors of society would be reduced so there would be no net amount of money for the government to utilize or use in any other way. Potentially it could be used to reduce, for instance, sales tax which is seen as a regressive tax. So there could be other taxes maybe income tax or property that could be reduced and creating a revenue neutral tax. In fact most economists do support it. If you're going to collect taxes you should tax those things that you want to discourage and not tax the things you want to encourage. So maybe it could be used to create a more efficient economic structure within the U.S.. If there is some revenue that is kept it could be used for carbon emission reductions incentives, slow increase in the tax could allow for transitional investment adjustment and development of new technologies. The revenue recycling issue

is really just returning that money to the economy in other ways. That would be the same as revenue neutral carbon tax or for instance taking that money and using it as an incentive to new technologies. For instance renewable energy or low carbon emission carbon capture and the like. The cons number of cap tax are politically unfavorable – there is an unpredictable outcome and it is very difficult to know what level of tax is needed to get the reduction in carbon emissions that is necessary. So when you perceive that when you wanted 80 percent reduction in carbon emissions by 2050 what level of tax do you need to get that and do we have enough time or enough ability to really ramp it up to that level and what would be the repercussions of that. In addition, revenue to carbon taxation will go to other governmental areas and that could cause problems. A lot of folks probably don't want the government collecting more money and spending it. It could burden low income families, some consider it a regressive tax that could distort the economy to some extent and could slow the economy.

Cap and trade tax in comparison is an economy wide emissions cap. Credits are an allotted option to larger carbon emitters obviously all that emit carbon it would be very challenging to monitor, very small emitter, so it would be just the largest that would be monitored. The emitters can sell or buy carbon credits on the market. The cap can be reduced over time to reach emissions goals. Those emitters with the lowest costs reduce their emissions would act first and be able to sell those credits to those that will take longer to reduce and have higher cost for reduction. As the carbon price increases, reduction becomes more attractive than credit purchases.

One of the issues with the cap and trade is the complexity as to the requirement for somewhat complex enforcement as well but the pros have been cited as it will guarantee that emissions reductions target will be met. It is much easier to set an 80 percent reduction for instance, then monitor that and restrict the credits as time goes on to meet that reduction. In addition, banking, auctioning and safety valves could help reduce price fluctuations which can be a problem. Permit auctioning provides revenues that can be recycled back into the economy through clean energy incentives or to ease the burden in lower income brackets. Again that could be also taken as a negative and that means that the government is taking in money that is then spent in various ways and that there obviously could be a lot of special interests that may be able to have access to that money and may not be the most efficient use.

In addition to auctioning, revenue recycling can increase economic efficiency through auctioning those credits and then re-investing that money as mentioned earlier. Some of the cons, large fluctuations and unpredictability in permit prices can make it difficult to decide on some of the best strategies. I don't know if any of you pay attention to the carbon market but there are dramatic fluctuations and it makes it a little bit more challenging for businesses to know what they need to do and how they need to plan if they are unable to know how much their emissions are going to cost. It is also high complexity to the trading regime and difficulties with enforcement. Allocated credits are challenging and could provide windfall profits for polluters. In Europe for example, they allocated too many credits and those polluters eventually made millions and millions of dollars by selling their actual credits as offsets to other areas of the economy that needed them. So that was not the intent to give one windfall profits to energy companies or coal burning power plants, so

that is a problem. The comprehensive program would have to be developed to cross many sectors, complicating the trading system, and trading regimes may be less efficient than carbon taxes. According to economists, again there is a little bit more complexity involved. Again the low income families may suffer, however if there are revenues that are gained possibly auctioning could be invested in helping low income families stay through likely investments.

I'll just take a few more minutes for a quick summary of state climate policies. This is just a quick glance of some of the various policies that states have looked at. One of the things I wanted to note that there has been so much focus on the cap and trade and as well as possibly carbon taxes that I think as you saw from the earlier chart that I presented that it's immense how many different disparate little areas need to be looked at or be assessed. Many of them are a lower negative cost and it is possible that these cap and trade schemes may not efficiently access those. Many states are looking at a whole host or combination of different policies and this is just a list of a few here. Some of the policy design issues to consider are what portion or carbon emissions will come from cap and trade or carbon tax versus say renewable portfolio standards, energy efficiency and other mechanisms. California, for example, in its breakdown expects cap and trade to contribute less than 40% to overhaul greenhouse gas reductions. So they are looking at their many, many other programs, energy efficiency programs, renewable portfolio standards (REPS), renewable fuel standards and the like to reach the other 60% and also complement their cap and trade program. Carbon caps do not reach all sectors equally, for instance, the high carbon price of $150 per ton which is much higher than any reasonable. I think economists have even forecast to be possible would be needed to be an incentive to use solar energy at this time. Other incentives that you may wish to at since it is different costs for every different sector and while looking at the lowest cost, it might get the lowest cost first, the problem is that if carbon reduction the 80 percent is to be met, I think most feel that many different options needs to be addressed at the same time. Not 20-30 years from now as costs decrease.

In addition most of you envision some signals are necessary for the private sector to plan accordingly. California was the first to introduce a mandatory carbon cap and many were modeled after this so it has been a little bit of time there. Caps to 1990 levels by 2020 and 80 percent below by 2050, it is an enforceable emissions cap and requires reporting and monitoring to enforce compliance. That is really one of the critical elements of any greenhouse gas reduction program is to have monitoring and enforcement and this is all taken care of through their State Air Quality Board. It is a massive program - they are hiring 120-140 full time staff just to administer it. The early action plans are plans that they actually are implementing by 2009 as a result of this bill. They include greenhouse gas emissions, control regulations for mobile sources including the low carbon fuel standard, there is also the land fill methane capture which is requiring all landfills to capture methane. Energy efficiency building requirements – they are looking at having potentially what is called net zero buildings by 2020. So they are requiring that all buildings built generate as much energy as they consume which is a pretty large step. That would be for all large buildings by 2020 and then by 2025 they would be looking at that for residential. Other measures include increased use of CFL bulbs, increased building insulation standards, increases in demand-side management, all of which involve many departments across all government.

That is just a list of those states that have actual emissions targets, seven states now have implemented mandatory emission targets with just Massachusetts and Connecticut introducing and passing bills this year. Most of those are looking at meeting about an 80 percent reduction below 2005 levels by the year 2050. This is just a summary of earlier action in 2007: Hawaii, Minnesota, Washington, and New Jersey and some of these also are participating in regional greenhouse gas trading plans such as New Jersey. It is actually a part of a mandatory regional greenhouse gas reduction initiative which nine states are participating in the northeast and they will be trading among all of those states to reach a ten percent reduction by the year 2020 or 2015 I believe it is for all of those nine states. These are just a few of the other California climate policies that they are implementing. Very significant and aggressive they are pursuing this as very challenging. From what I have heard this is a very huge challenge but they really are pursuing it aggressively. This is just an example with regard to energy efficiency and California has been aggressive since the mid 70's with regards to energy efficiency policy and you will notice that relative to the rest of the U.S. the growth in per capita energy consumption has essentially been stable or zero since 1976 has increased by about one-third for the rest of the U.S.. That had a net savings of about $1,000 a family per year. There are significant gains to be had through energy efficiency.

This just shows those states that are following the California greenhouse gas vehicle emission standards. So states can either choose the federal standard or the California standard. California is requiring a 30 percent reduction in the emissions of CO_2 in their state that is currently under consideration. The EPA denied that and is certainly being pursued in the courts. I believe they will probably at this point allow California to follow that. These are the states actually 17 are poised to adopt that standard which means that any car that gets sold will need to have this 30 percent reduction in greenhouse gas emissions by 2018 approximately.

This is a brand new bill just passed in September, a large component of emission comes from transportation and not just due to the fact that vehicles are inefficient but because of the line of communities require long distance driving and require individuals to consume a lot more in energy than they normally would in a community where they have easy access to work, school and recreational areas. SB375 adopted in September requires that each metropolitan planning organization adopt a sustainable community strategy as part of its regional transportation plan and requires it to meet greenhouse gas emissions reduction goals for automobiles and light trucks in the region. It is going to require that they do some types of transportation design whether that be through mass transit, and other types of transit implementation as well as redesigning communities so that there is much better access to the areas where the individuals need to travel.

Finally, I'll stop with this last one here. Carbon sequestration is another area where there are quite a bit of options for reducing greenhouse or at least countering greenhouse gas emissions and it is one of the less expensive options as well. Washington has introduced a bill which creates the forestry carbon offset program and establishes voluntary allowances and accounting systems for carbon storage within the forestry industry. Other states are also considering this and actually ten percent of U.S. carbon emissions are offset by the

forestry sector. There is a significant amount with re-forestation and also agricultural practices there is a significant amount of carbon that can be stored within the soil through a change in agricultural practices that are not very challenging to implement and they can also increase soil productivity as well. A number of states are looking at that. Finally, some considerations – energy efficiency is the least cost greenhouse gas reduction approach. Visible sustained signals are required so that the market can incorporate less costly emission reductions. A coordinated approach is needed for tackling the many abatement options and verification and enforcement are essential especially for businesses to realize what their cost will be and to know that they are playing in a level playing field. There are also significant infrastructure needs that may not be covered by these initial policies, so building transmission and also new types of smart grid issues which will allow consumers and the utilities to really access and pass energy efficiency and distribute energy potential.

We have a number of publications, we do policy tracking, we have a data base and I really raced through this, I probably could have spent an hour on each topic, just on allocating credits that is a topic is quite extensive as well. I am happy to answer any questions in the future and you can contact me by either e-mail or by calling me as well. We do have a tremendous amount of resources on our website which I've lifted there including our legislative tracking data base and a host of publications. Thanks are there any questions?

Representative Harrison: You sort of eluded to it, but for states that have in place on cap and trade programs or at least have a carbon cap program in place are they in a better position than federal cap and trade policies are adopting at the state level?

Mr. Anderson: Yes – I would say that those states that already understand the implementation and how the markets will work and have operating markets for instance, the northeast regional greenhouse gas initiative and they already have an operating market. It is uncertain if the cap and trade is adopted at the federal level whether they will adopt what is already existing and then just expand a model of what is already out there instead of redrawing everything to encompass those states that are not participating. They are already in operation – there is a Midwestern regional cap and trade, there is a Western Governor's Association and then the Western Climate Initiative and then there is also the northeast. It is uncertain as to how that will work but I think that it will give those states a leg up in that they will already understand how to implement this and they may be able to jump on more quickly. The other advantage they may have is they are already reaching goals they may be able to sell within the Regional Greenhouse Gas Initiative. These carbon credits are quite valuable and other states are actually funding programs to sell these credits. Every year they get a certain amount of allotment and they can sell those credits. A number of states are able to sell those and then they are actually funding some of their energy efficiency programs. So the economics of the situation is that those states that have already made some progress are likely to be able to gain more when a federal law passes.

Representative Harrison: Thanks and just one more on the efficiency requirements that Minnesota has one and a half percent each year and then I think Vermont has one as well. How are those implemented, is it the Utilities Commission or...?

Mr. Anderson: Yes, in Minnesota it is required that to potentially sell energy which is the main provider in Minnesota it is required to meet this one and a half percent per year. Initially they just had to spend a certain amount of money but the Legislature wanted to make sure that they were investing it efficiently. So then they changed the requirement to be one and a half percent per year increase in energy efficiency. The Minnesota Public Utlities Commission (PUC) oversees that to some extent, to the extent that they make sure that the data reflects that but the implementation is completely overseen by utilities.

Dr. Eggers: I think it is great that California has done SB375. The metropolitan planning in North Carolina could certainly benefit from looking at that. One of the things that keep coming up in my conversations with planners is that they will say we can have great plans but what's really shaping our growth is the North Carolina Department of Transportation (DOT) long range planning and of course the manifesting of those long range plans for road widening and beltway construction and all of that. And that actually undermines local government plans because it is such a strong force in where developments are actually located and our DOT right now uses existing growth patterns just projected into the future. In fact the conversations I've had they don't call it a straw pattern they say we just project what's going on now and into the future and we build roads for that which is a straw pattern. Are there any states that actually have language that directly addresses DOT long range planning and long range road widening projects and things and what.

Mr. Anderson: I definitely think the California language, the way that's designed, it requires those regional plans and taken into account and that encompasses the DOT from what I understand. So that there would be a collaborative process there that they don't ... for instance I am sure there are safety issues and making sure that they get fire engines and that sort of thing to the places where they need to get; but from what I understand they are collaborating on that as well. But that is a huge issue and I am sure a lot of the augment has been that well it's a free market and this is the way our communities are because of free market. In fact it really came down to the way the planning and zoning was created. Our developments have been created by zoning not by necessarily the free market. So zoning was created before the communities grew. I think that yes restructuring the zoning requirements is probably one of the largest, the best ways to contribute and first allowing them to and then possibly restructuring the way the DOT works but obviously that takes the state and federal actions to some extent who they are funded through. There may be stipulations that the federal government will not fund certain road projects and must comply with certain requirement on the federal side.

Representative Harrison: I don't want to sort change our other speakers but we'll take one more question – Ivan.

Mr. Urlaub: I had a chance in October when I was in California to have lunch with the person that's in charge of SB375 planning for San Diego area through (inaudible). It was pretty intriguing just how well integrated their look at it is of transportation development, carbon energy, water. I am curious, are other states already talking about it or are you aware of any other states that are talking about this more integrated planning where they bring you energy and these other resources and carbon together?

Mr. Anderson: I know that Minnesota is quite aggressive as well about their climate demand and they have been talking about the smart growth issue for a long time and its growing energy as has Colorado. There hasn't been, to my knowledge, a lot of activity in the Legislature trying to make a connection and restructure the planning process. Besides California, I think there have been some bills introduced but I can easily find that information for you if you like. But off the top of my head I don't have, I know that California was the first one to actually enact any bill like that.

Representative Harrison: Thank you Mr. Anderson and I think you said you would be around for a little while if anyone had additional questions. Mr. Smith you are up next to introduce our next speaker and I neglected to thank our sergeant-at-arms. We have John Brandon, Dusty Rhoades and David Shearon and Charles Williams from the House and Charles Marsalis, Ernie Sherrell and Ron Spann from the Senate. Thank you all. I'm sorry I forgot to recognize Secretary Ross as our distinguished guest today. Thank you.

Dr. Smith: Good morning I just wanted to briefly introduce the next speaker- it is great to be back after the historic election and I think there is a lot of opportunities now that will unfold as we move forward. Our organization, SACE has for the last couple of years been paralleling very closely with Tom Peterson's group at the Center for Climate Strategies (CCS) in a number of southeastern states including North Carolina. And as part of that process we wanted to take a very focused look at building a road map for getting significant reductions in global warming pollution in the state of North Carolina very specifically and come up with very key elements, what we call cornerstones, to really get those policies moving and so this report each of you should have gotten this in the mail about six weeks ago. Hopefully you have and if you haven't it is available on our website at cleanenergy.org and you can certainly talk to me or John about getting a copy. John Wilson is our Director of Research, he received his undergraduate degree from Rice University in Physics and History and then a Master's in Environment and Economics from the Harvard Kennedy School of Government. He has been working on this project with us as well as looking at other southeastern states and he is going to outline for you some of the specifics findings that we came up with that will parallel some of the things that we've been talking about and then I hope at the end we will be able to dig into more specific discussions about some policy recommendations that we may want to look at in the up coming year. John.

Mr. John D. Wilson: Good morning and thank you very much Chair Harrison, Mr. Givens and members of the Commission. The report we put together is a comprehensive look at solutions to global warming, that is our focus and the first thing we wanted to do was simply to frame up kind of conceptually what these are. If you've tried to read the 450 page report from CAPAG, it is a really comprehensive analysis and we drew very heavily on it. But what we wanted to do was also present this in a way that would help people remember and stay focused on the key solutions to global warming and those are energy efficiency, clean energy, pollution capture and long range planning. Our goal in this report was to outline how we could get to a 60 percent reduction in global warming pollution by 2030 and that means going from about 180 million tons of global warming pollution right now. Without action we would be going up to 280 million and with action we think we can get down to 65 million. And the kind of solutions we are putting forward here today which are in many respects represented in the work of CCS process the CAPAG report are things that

are either technologically feasible today or things that with aggressive effort can be engineered to be technologically feasible, in other words, the things that are available in the market but may be require some innovation in terms of how they could be delivered cost effectively. Not really relying on scientific breakthroughs or any kind of thing like that. The other thing I would like to point out about this project is that today the average residence of North Carolina is on average responsible for about 20 tons of global warming pollution emissions per year. When I think about my four year old son emitting 20 tons of global warming pollution it is kind of a staggering thought. Of course that is an average so it may be not my four year olds responsibility. If we leave that unchecked and we continue with business as usual that number would go from about 2020 to about 23 tons per person. In contrast what we are proposing as a separate number of actions that would reduce that to six tons per person. Which still to me sounds like an awful lot but it would be a staggering and monumental change, so I want to emphasize that what we are talking about is a very large transformation and no one should think that this is going to be a simple process. Yet it is very doable and I think some of the material in the previous presentation illuminates that sort of the silver bb's approach is absolutely correct and we try to flip those bb's into these four compartments of the different cornerstones.

To give you a little bit of comparison between the two reports for the CAPAG report go back to 1990 and in contrast we started ours with 2000. We have a slightly different inventory in forecast. We use some updated data that were available at the time we got started on our technological analysis in comparison to some of the little bit older data because of the different start time and the different models that were used in the CAPAG report. You see some differences in the numbers, we also in addition to updating a lot of the data and the forecast data we had some technical adjustments based on more recent policy and scientific findings that resulted in somewhat different trajectory. And also we are urging somewhat more rapid and somewhat more expansive policies in our report than was agreed to by the CAPAG report. So we came out with about a 30 percent reduction versus 2000 in comparison to the 24 percent reduction and this is comparing 2020. We went out to 2030 as I showed you before so in the CAPAG only went out to 2020. This is just kind of trying to benchmark those two so that those who are deeply familiar with that report will have a sense that this is very similar to the exhaustive report that was done for the State but a little bit different in some respects.

The highest priority recommendation we came out with and this is energy efficiency and that actually is responsible for about 50 percent of the potential emission reduction that we project by 2030. And by energy efficiency we mean those are the things that might immediately come to mind like, for instance, compact fluorescent light bulbs and energy star appliances, we are also talking about major building renovations, improvements in energy efficiency for the industrial and commercial sectors. We are talking about energy recycling which is sometimes known as combined heat and power or waste heat recovery and we are also talking about fuel economy in the transportation sector. This is a really critical area and it is important to get going on this very quickly because if we delay action, we really do miss opportunities and I think that was discussed somewhat in the previous presentation.

Just to kind of recap on energy recycling – this is one of the modes of this where instead of allowing a lot of waste heat to go out from a commercial, industrial or power generation process, you capture that waste heat and with no added pollution to the air you can generate additional steam and electricity. It is a really powerful tool for cutting global warming pollution and it is one that is currently across the southeast vastly underused. We are working on an initiative at our organization and they are looking for partners to develop a more extensive program to identify exactly what's holding this technology up in the southeast and overcome those barriers.

More conventional energy efficiency when you think of utilities or state agencies or individuals going out and investing and using and wasting less energy. It is by far the least expensive strategy to address our energy needs for the future. In comparison, this is a study done by Lazard which is one of the national consulting firms that benchmarks energy costs and it estimates that typical energy costs in investments in new generation are now costing, really in the range of 8-20 cents per kilowatt hour for most of those investments that are being made. And in comparison, energy efficiency is really down in the range of 2-4 cents per kilowatt hour. One of the critical things to understand is that this is not the case if you make a half hearted effort. This is a very interesting study that was recently released for the American Council for Energy Efficiency Economy by Synapse Energy Economics and you can see there on the chart that the (you probably can't see it that carefully) but what I can tell you is that there are a number of utilities that are profiled there. Each one of these it shows that as their energy efficiency investment grows, as they achieve greater and greater results the cost goes down. One of the things we are often tempted to do is think of energy efficiency as sort of in the low hanging fruit metaphor. Taking my kids out apple picking and they are the ones that get the low hanging fruit. And while I can tell you that it is a lot of fun to get the low hanging fruit it is not actually the most efficient way to get fruit off a tree. The way to get fruit off a tree is to bring out some skilled folks who are good at it with ladders and tools and strip the whole tree bare and move on to the next one. And that is what utilities across the country are finding with energy efficiency is that the more aggressive they are, the cheaper it gets. And this should not be a surprise to anybody – this is an economy of scale arguments that is very frequently applied in business. But for some reason we tend to think that when we see those charts about some of the costs being very low and others being high that we can sort of start with the easy ones and then move on to the more expensive ones and that is the way we ought to progress. In reality, the way to get it all as cheaply as possible is to go after everything at once, as fast as possible, and as cheaply as possible. Thinking in that way is very critical and so one of the policies that I think we would like to encourage would be a State energy efficiency resource standard or a standard that the state says such as the one that was discussed earlier from Minnesota of going aggressively after energy efficiency. We have a little hint of one that is often recognized nationally is that in the current renewable energy standard, but it is not nearly aggressive enough and it is not nearly as direct and focused on the issues.

The other issue that often comes up with energy efficiency is a challenge in thinking about what energy efficiency is and I've got a highlighted case that I'm looking at – Florida here compared to the southeast in the red dots there. You can see that the southeast in general, the large red dot near the zeros is every state in the southeast except for Florida and basically there is almost no energy efficiency investment in the southeast. In comparison,

California is all where you would expect it would be, way over on the right. California is a national leader on energy savings but in terms of capacity which is how much power is needed at peak periods is actually not California it's the Great Plains. And that is very much reflective of policy decisions that are made at the state level as to what direction we want to go. This is not a circumstance of geography it is what decisions have been made by political leaders and policy makers. So this Commission has an enormous opportunity to have that kind of impact. In Florida the decision in their very deliberate decisions that have been made for understandable reasons, not reasons that I would necessarily agree with, but understandable reasons that have lead to the focus on avoiding capacity which means fewer power plants get built, but not less energy use. And so the energy efficiency results is that the utilities spend less money investing in power plants but the customers are still buying almost as much energy as they would have otherwise and therefore their bills don't go down so there is not the savings for consumers. This is a fairly complicated argument that we could get into in more detail but the point being it is not all energy efficiency is created equal and it takes a focus on energy savings and global warming pollution reductions to make sure that it will have the benefits that we want.

How do we achieve that? First, as I mentioned one of the ways to do it is with state policies that can reduce energy use in homes, buildings and factories. There are also policies we can use to address the energy recycling issue specifically and finally, fuel economy, I haven't talked a lot about that. We are very supportive of the states adopting the California Clean Cars Standard, but ultimately I think that it is important to understand that this is an issue where we would require both a lot of better engineering of vehicles and also the power system so that we can move to things like plug in hybrid electric vehicles or even electric only vehicles which will drastically reduce global warming pollution. And second, to recognize that the federal government is always going to have a very strong leadership role in this area. This is a contrast area regardless of what happens with the federal government level it is going to be the state Utilities Commission and the State Legislature that is going to drive the shape and direction of programs related to energy efficiency investment in the state. But when you're talking about the fuel economy portion that is going to be a much more federal leadership area with the state playing a sort of secondary role, and so understanding that the state, regardless of what happens at the federal government level. It's going to have a huge role to play and it's essential for this Commission as it moves forward as we start to hear a lot about discussion at the federal level about different policies. Another thing about energy efficiency that is really important to understand is that it really helps us to achieve other goals that we might have with the global warming strategy. Less electricity demand means that it is easier to reach renewable energy goals. In this graph you can see outlined in red the energy efficiency component of the electricity generation forecast that we have for the state of North Carolina. If we don't take any action, we believe that energy generation would go from about 130 million megawatt hours all the way up to over 200. But with this program we would actually only need to generate from central power plants a little bit less energy than we currently do right now. We would actually have a decrease in central power plant generation and an increase in other ways of meeting our energy demand. So we would be shifting from sort of a 20th century approach of thinking of how much electricity can we sort of push out and instead think about it as energy services. How can we meet people's needs and desires with energy in the most efficient manner possible?

The other thing that is really exciting about this kind of switch is that it is actually a lower cost approach overall. The energy efficiency approach and the reduced risk of fuel cost by means that this would be a lower cost approach to generating our electricity needs than the business as usual approach. And finally, it is also very important because it saves water resources which are so critical to the State. The less energy we're generating in coal and nuclear and gas plants, the less water we're using at those facilities and therefore it makes it available for both other needs of people and also for environmental needs.

Similarly there is additional sort of side effect of benefits that we will get into in terms of energy recycling and also reducing fuel demands and together this means that energy efficiency strategies make the whole package work a better if they are aggressively perused. That is one of the reason that it is so critical that we not delay or roll these programs out gradually but that we go after them aggressively in a manner that is very sustainable, that we can count on these programs delivering results year after year after year in greater numbers.

The second cornerstone as I mentioned is clean energy and in terms of electricity this is sort of the mix that we think is feasible for North Carolina to build out over the next two decades. Specifically in terms of wind, we are looking at both ridge top winds where we have about 11 million megawatt hour potential at low impact site from the ridge top and then a huge amount of potential in off-shore wind. Really from the point of view of the future of the state a limitless potential and this has been an area that North Carolina I think has been slower to recognize than even as other states in the southeast like South Carolina and Georgia. They have a site off the coast of Georgia where the state and federal government are cooperating to sort of initiate the permitting process in that region. So we are seeing steps in the southeast that are positive steps (inaudible) really enormous resource. We think that it is certainly feasible to see a total of 20 million megawatt hours from basically zero today to generation by 2030 and that would only represent less than 10 percent of the feasible generation. In other words, to places where any sane person might think it would be reasonable to put a wind turbine once in five percent of the theoretical potential. We sort of carved out all of the bad sites there and it is still an insignificant portion of those.

Mr. Everett: Can I ask you a question about that. In your original graph kind of where you want to get to ....

Mr. Wilson: This one here?

Mr. Everett: Well really back to the original reduction. So what happens if in fact North Carolina doesn't take the steps to make those wind resources available? Do you have enough capability to modify that curve and say we don't do this it changes its projection to X?

Mr. Wilson: Yes it is interesting that you ask that. We have had actually this exact same conversation with many of our allied groups as we formulated this report because to take a different approach, let me skip forward here actually to the full electricity generation graph, right here. For instance one of the assumptions we made in this report was that we would

hold nuclear power steady across this whole report and one of the things that some of our allies said is look what if we wanted to phase out nuclear power completely and the existing power plants would be shut down. Well the answer is you need to make up for that with some other strategy and we think we've maximized the potential of clean energy and energy efficiency in this plan so you would have to look to some of the other resources to fill that gap in the interim. In the long run there are other things that we can be doing as we continue to build these out. So we put down a very aggressive build out schedule for wind energy based on trends in the energy industry in terms of how quickly and new hybrid technology can be adopted and brought on. There is a lot of, I will not say precision thinking behind this, because forecast is inherently wrong, there is no way to be correct about a forecast of any kind whether it is business as usual or the adoption of policies. But that said it is better to be wrong smart than wrong dumb and what we did was we took a very informed look at how the different technologies in the energy sector had been adopted, their adoption rates and applied that to the wind power sector to say this is what would be a reasonable build out rate for North Carolina.

Mr. Everett: I would just tell you we put out a request for proposals for wind energy at the utility-scale and we didn't get any proposals. We did get one that was infeasible in fact the project could not go forward because of hurdles that it faced and so I just wondered in looking forward whether 2015 or 30 and you project some large increment in wind in North Carolina. I know it is feasible in terms of the wind energy in there but currently we don't see anybody bringing us proposed to do, the ones that do come are very cost prohibitive or I guess in the third case, they can't get a permit to do it.

Mr. Wilson: Yes and we've heard that concern from your company and others and we've actually talked to the wind developers and what they've told us privately is the RFP process was not a good match for the way they develop projects. And we are aware of at least two projects that are currently being developed in western North Carolina. I don't know the specifics of them but they are going methodically through the first stage of the process which is to talk to the land owners first. They would really rather talk to the land owners first and get their buy in and then began to go public with the project and start negotiating with the utility and with public permitting issues. The idea that they would sort of submit to a RFP when they don't have the buy in from the land owners and the awareness of the community I think would concern them in terms of development process.

That said what we've got in here is the big increment in 2020. We see most of that coming on line in the latter half of the decade. I think the initial projects will be developed by 2015 but really I think that most of that is coming on line in 2020 and what we projected there was primarily ridge top wind in the early phases but by the end of the decade an off-shore wind development. Again, that is a very aggressive schedule I would agree that's going to take policy leadership from the state and if we don't have that policy leadership it is not going to happen because developing off-shore wind requires coordination of offshore permitting it requires transmission, it requires utility buy-in, requires involvement of coastal communities. All of those things need to mesh together. That is not going to happen just sort of willy-nilly it is going to take integrated leadership from the top to make that happen but it can be done it is not infeasible.

Dr. Smith: I think that in response to George's question the other big unknown is that the Minerals Management Service is still working out the actual off-shore permitting and rules. So a lot of the off-shore potential is not going to bid in the short run it is going to be coming in the next couple years as those rules for off-shore wind are further refined and then there is this outstanding questions about the ridge law that ultimately needs to be resolved here in North Carolina about the ability to in a sensitive way to develop certain areas in western North Carolina where you can tap into some potential, again requiring state leadership. Those are issues that I think are all sort of holding back this but I feel like they will be overcome in the short run.

Mr. Wilson: This is fundamentally the reason why we named the report exactly what we did calling it cornerstones. We are not saying this is the exact outcome in 2030 but we predict it will happen with certainty. I mean that would be crazy. These are opportunities for the state to change the way of its economy and how it relies on energy for the future. And if each of these four opportunities are taken and built on, exactly how it will evolve, exactly how the Legislature will respond to this and put it into action is out of our organization's hands to a large extinct. But we think this is directionally and helpful to see how these things fit together and that has been one of the major things we've tried to do in this plan.

Hydro-electric is another area that is of a lot of interest. We are projecting a modest increase potential for hydro-electric with basically very low impact facilities. This would involve shifting again the paradigm of electricity generation from central generation to a more distributed generation approach. And as an example, in Denmark over 50 percent I believe of the electricity that is used in Denmark is generated from distributed generation sources, combined heat and power and wind being the two major components of that in that country. In contrast well over 90 percent of our energy in this country is generated at central generating stations. This is a very different approach it requires a different way of thinking, a different way of operating the entire electric system. Again not a trivial thing that can be done overnight, but requires deliberative planning and execution.

Bio-power is an area where we see really the most rapid potential near term impact on clean energy resources. What we are talking here about agricultural and wood ways being the initial sector that you would draw from and also growing energy crops which happens to be very well on land that is poorly suited for food crops. So this would be the area we see moving most rapidly in the near term and a huge expansion of this.

Solar energy is an area that is really evolving – at the time we put together our plan there were not a lot of details forecast as to how much solar energy could be available in the southeast. Yet we're seeing both Duke Energy and Progress Energy putting out pilot utility projects both at the utility scale and we are also seeing a lot of small scale homes and this is being driven by again state policy, the REPS law. Solar hot water is a cost effective area and we're seeing a lot of rapid growth there. Yet nevertheless, we are seeing the customer's base problem – the recent report that tracks net metering rules, for instance, around the country gave North Carolina an "F" in this area compared to other states. In contrast, I think we got a B on the interconnection standards that have been recently overhauled. There are a lot of details there and there are others here who are better suited

than I to get into those matters but this is an area where we really need to be looking very carefully at how the whole system works, the rules, the rates, etc.

In terms of fuel – we looked at regionally produced bio-fuels and we think that realistically we can get to 25 to 30 percent of demand. But that really depends again on meeting the efficiency targets. We've got to get much more efficient vehicles if we are going to get to 25 or 30 percent of fuels from regionally produced bio-fuels. We believe that bio-diesel and cellulose ethanol would be the key pathways to that solution.

The next cornerstone is pollution capture – I am going to start out with geologic. This is the one that probably comes to mind first for many people here and we actually looked at this and we were able to integrate several different reports and come up with a cost estimate. Again this is one where efficiency and clean energy makes this possible. If we can reduce the contribution of coal to the overall energy mix substantially, then we can keep this cost down to about 800 million dollars per year to run a carbon capture and storage system for the state of North Carolina. This would be less than one cent per kilowatt hour of generated electricity in the state. So that would be a really manageable cost we believe and sort of a component of the solution that we believe is necessary to make the whole system work. And that goes back to Dr. Everett's question a little earlier.

So integrated together this is sort of how the whole electricity system works and we have already kind of gone through this so I will just pass on by this. We think this would be a responsible direction to head in terms of our electricity usage. The other aspect of pollution capture is landscaping pollution capture and here what we are talking about is across landscape, agricultural forest and even urban areas. I think urban areas get a lot less attention. But what we were looking was strategies to achieve a 20 percent increase in carbon storage and soil. And this would take us back no where near those historic levels of carbon that were in the landscapes in sort of pre-European settlement era but it would be a substantial increase. An improved management practices in all three of those sectors will go along toward doing that. One of the technologies we highlighted is biochar and I believe there has been some presentations to this Commission on that so I will not go into a lot of detail. That is just an example of the kind of approach that have been used and we think could be adapted. But this is going to require a lot of research and policy direction from the Legislature to see these things put into place. They are not just going to happen on their own. A lot of the experts who know how to do this are out there, they're already employed in the right institutions but their focus is not on increasing carbon in the soil. Their focus is on other policy matters and so it's just a matter of sort of redirection and refocus of these institutions in a lot of cases.

The final cornerstone that we've included in this project was the long term planning cornerstone. And the first thing that's really challenging about this is how slowly it developed even though we assumed that the policy would be put into place very rapidly, that the State Legislature would encourage or direct the appropriate policies, it take really all the way into 2020 to 2025 before you start to see that red stripe down there grow fairly wide. And that is because communities take a long time to evolve and we relied heavily on a lot of really excellent planning research. Ivan was discussing SANDAG that is one of the leading regional planning organizations in the country and organizations like that are

starting to think about these things but no one has really put together the package yet. This is a very challenging area and it is one where North Carolina could really be the model leader in the country if it so choose. How important is this though? This is one of the policies that really have a huge impact on family budget. And one of the things that was kind of exciting about this kind of a policy area is that there is sort of this perception that sprawl is a cost effective strategy for families to deal with their budget issues. And what this graph shows here is that actually when you look at families earning 35 to 50 thousand and I just selected that income group, but it is representative of the same story that is told in other family income levels. The amount of family income that they spend if they live away from an employment center on housing and transportation is about 50 percent. It only substantially drops when they are living in the central city. So regardless of whether they are living near an employment center or far from it, it's the combination of being both near schools, job and services all at once. It really begins to dramatically reduce both the cost of housing and especially the cost of transportation. So the kind of strategies that we are talking about in long range planning that put people together with services and jobs and schools and everything in one place, are the kinds of strategies that benefit families from an economic point of view. So again, this is not about a trade off between quality of life and economy and global warming pollution, it is about both of those things going in the same direction.

Of course there is also the sort of long range planning perspective that I know some of the later presentations are going to get into with adaptation and certainly sea-level rise, I think this is Elizabeth City shown with a substantial sea-level rise increase. You've got to integrate these two concepts, you can't think about adapting to a different climate in the future without also thinking about how you mitigated. Those two things go hand in hand, you've got to be designing cities for a different future and this is really challenging. I read a recent story about how the Nature Conservancy is struggling right now with its land purchase planning because they are trying to put the habitat, not for the plants and animals as they exist and live today, but for the plants and animals of 2050 or 2100. And of course, it was discussed earlier the forecasting of climate models is not that refined so that it really presents a huge scientific challenge for that organization. You can repeat that story for the road builders that Dee was talking about or any other aspect where there is long range planning going on where you have to take into account strategies to both reduce energy use, capture more carbon and deal with the impacts of global warming on communities. And just to give you a sense of how dramatic this could be, relative to 1900 we've already hit half a foot of sea-level rise globally. This is the most recent sort of forecast by one of the authorities in the field who is heavily involved in the global work on this topic and he is forecasting by 2100 anywhere from two and one-half to four and one-half feet of sea-level rise. This is a very dramatic impact on coastal communities and coastal eco-systems.

So is a 60 percent cut in global warming pollution enough and the answer is, no. By 2030 that would not be enough to stabilize our emissions and get to the point of sort of 450 parts per million, which is what a lot of people have said is almost surely dangerous. And recently James Hanson, who made that comment is now talking about maybe we need to get down to 350 parts per million, which would be below today's levels in the atmosphere. So his point is that we may have already shot where we need to be. So this is an enormous challenge. But what we're hoping is that if we can get on this path two decades later we are

at the 50 percent cut that by then we will have the technology, we will have the ideas, we will have the insight or we will have the will to change our behavior or whatever it takes to go the extra mile and get to where we need to be in 2050.

Just in summary here are some of the numbers – I will not go through these in detail but we are happy to provide you with support individually or as a group on the specifics of each of these areas. A lot of this work is already contained in the exhaustive and broadly accepted report from the CAPAG commissions and look forward to working with you on this. I wanted to kind of sum this up in this slide, I apologize for that. These are the four areas that we think are really most right for legislative action in the next session. The first is a energy efficiency - we do have a recommendation that this Commission has adopted for appliance standards and building energy coast that has not been turned into legislation. So we do need action on that. The second thing would be a state efficiency standard that goes well beyond the REPS rules and is actually a standard specific to energy efficiency. Similarly, we would want that extended to natural gas energy use and finally we need an energy recycling program. This Commission has adopted recommendations for a study of this subject and for net metering to be addressed but we do need actions from the Legislature on that.

Again, as Steve mentioned earlier, we need some changes in the laws and permitting programs to foster inland and offshore winds. In the area of pollution capture we have the possibility, in fact, yesterday there was a federal court ruling that addresses this topic, there is a potential that now any new power plant will require best available control technology for CO_2 emissions. If that is implemented widely across the country we would be talking about a CO_2 emissions limit and that could be a way to get at fostering the need to capture pollution and store it underground. And finally there is a whole host of issues that are detailed in our report. I will not go into it, where we believe we need either state funding or policy leadership to deal with the research and policy questions. These are not big ticket items but they are essential things to get questions resolved for issues moving forward.

Thank you very much and I would also like to mention that R. Reeves our regional program director is co-author of this research (EXHIBIT J) with us and we are both available to assist you with anything you need on that.

Representative Harrison: Thank you Mr. Wilson for that excellent report. I want to give you all a heads up about plans for the afternoon. We'd like to know if anyone has any questions for Mr. Wilson and after that we discuss the content of this report some of the recommendations that the Co-chairs are considering and then we will break for lunch for about 45 minutes and come back to the adaptation presentation if that suits everyone. Does anybody have any questions for Mr. Wilson?

Mr. Everett: I wondered your estimate for what he might do for carbon capture and storage does that envision current coal plants or coal gasification plants that you've been capturing and storing?

Mr. Wilson: Yes I did kind of breeze over that – if you look up at the graph, the black are the current coal plants with conventional technology and what we envision there is the grey at

the bottom is the phase in of the plants that have the capacity for pollution capture. And what it appears now is that the only technology that is suitable for that would be new plants that would be using the IGCCC process and so what we are seeing basically the new generation of coal plants would be built and that the existing ones would be completely shut down essentially by roughly 2030. And that the new ones would basically have a 40 year life and then we're hoping that at the end of that lifetime, from our organization perspective, other solutions would be found.

Mr. Everett: So when you did your cost estimate on the per kilowatt hour, did you make an assumption about what the cost of coal gasification versus conventional coal in terms of building the plant would be?

Mr. Wilson: This particular increase is the capture component at the plant, the pipelines in the storage, so it is the additional cost of new capture and storage but it doesn't include the cost of the plant itself.

Mr. Everett: Which you should add in there if you want realistic estimates.

Mr. Wilson: Except that there is some degree of turnover in plants.

Mr. Everett: Sure there is but we are building a large coal gasification plant in Indiana and the cost is significantly different.

Dr. Eggers: Two questions – first do you know what the carbon concentration levels in soils were estimated to be in pre European settlement times. Like what percent down we are?

Mr. Wilson: I do not have that number off the top of my head but it is on the order of 50+ percent in reductions in fuel carbon.

Dr. Eggers: I was just curious I figured it much higher and bio-chard hopefully we get a refresher on this because a lot of the amazing possibilities haven't been covered yet in the Commission but thank you for bringing it up. Could you go back to slide 9 – alright I'm feeling kind of stupid right now so that y axis is the cost per kilowatt hour saved. When I think about the McKinsey report figure I think, ok so these are actual programs and actual cost per kilowatt hour saved and annual incremental savings, so if we think about this with the McKinsey report it seems like if we simultaneously optimize beyond the McKinsey graph that this is over and the distance is down and went for the cheapest best pay off things we could do first and marched on down the line. Seems like we might end up with a different kind of figure and if we went all the way out through the most costly items on the McKinsey graph seems like we might end up with a parabolic figure here. Are you following me at all?

Mr. Wilson: I am I mean what you're saying is that at some point if we really push the envelope will the cost start going up.

Dr. Eggers: Yes and also the x at the very top of the one that was the most costly and the annual savings... oh no excuse me, that was highest cost per kilowatt hour but yes not very much in terms of annual savings. Didn't they just pick the wrong thing obviously?

Mr. Wilson: What is fascinating about this topic is that there is sort of this impression that after we do the easy things it's going to get more expensive. We have the sense that there is going to be some expensive stuff out there and what's really surprising when you talk to people in the field, and this is really the first study that ever looked at this question. There is this concept that you can keep going back to the well. Don Gillian who is the president of the National Association of Energy Service Companies who owns a firm that does these kind of investments as well as working for this national organization, talks about going back into the same facility ten or fifteen years later and doing a follow-up energy efficiency upgrade that was more cost effective today than the one was many years ago first. Things get cheaper not more expensive and there is not a utility in the country that has come to that point where it starts going back up. Maybe that point is out there, we are not anywhere near that certainly in North Carolina where we are off basically up to zero on this chart.

Dr. Eggers: Right there is no danger of that happening any time soon?

Mr. Wilson: It is not something that I am worried about when advocating on these policies that things are going to start getting more expensive. We run into this with some of the utilities we talk to in other states that have been resistant to doing energy efficiency because they go out and they do a very small program and they find that the cost are six or seven cents a kilowatt hour. And they come to us and say, but you the collective you in the whoever we are, you guys told us it would be cheap and so they stop and the point is that the cheap programs are the big ones. The little programs tend to be more expensive. Now you can see that there are some of the smaller programs also come in more inexpensively and we can talk about the reasons for variation across the country in cost effectiveness with these resources. But the point is that this is a proven area that we've been doing these programs for three decades. Many of these programs you're seeing up here are in their third decade of operation. They are not discovering sort of untapped markets that no one looked for before they are going after second and third generation energy efficiency accomplishments and doing it very cheaply and very big.

Representative Harrison: Any additional questions for Mr. Wilson?

Representative Underhill: Thank you Madam Chair. You made reference back to the windmills off the coast that South Carolina and Georgia had gotten ahead of this. Could you tell me approximately how far off-shore these would be placed, is there any data on that as far as the view from the beach for...

Mr. Wilson: While there are, if you look at the maps the wind potential maps, there are opportunities that are close into the beach. The real opportunities are much further off and the advantage that we have in the south Atlantic coast is that the Continental Shelf extends out very far into the Atlantic and the wind generally picks up as you go further off-shore. So there is actually going to be sort of this trade off between the best sites the furthest off-shore and yet the additional cost of servicing a wind farm that is further off-shore and the

additional transmission line (inaudible) and so forth. So my expectations, we're talking five miles off-shore, maybe ten miles off-shore, these are not going to be anything that anybody's going to swim out to. They may be visible on a very clear day but I haven't been to the beach on a low humidity day in a while.

Representative Underhill: Follow-up? On to another subject – the small piece that was pink on your graph of hogs and landfill methane capture, does that include a complete doing away of the lagoon system in North Carolina, moving to other technology? Not going to do away with landfills but I know there are many people who feel strongly that we should be moving in that direction but you didn't make any mention of that.

Mr. Wilson: Yes I know there are a lot of details in here. In that case, I believe we assumed a 90 percent accomplishment by roughly 2030 I don't remember exactly what date in our model we picked of the large farms. The smaller farms we don't expect whatever be cost effective but that's less than 10 percent of the big farms in the state, so somewhere around 80 or 90 percent administration rate into that market. So essentially basically what you said but not exactly.

Representative Harrison: If I could just make a comment and ask a question on the wind issue we have at the Environmental Review Commission (ERC). We heard a brief presentation from the Environmental Management Commission which is looking at the permitting issues and the Coastal Resources Commission is looking at the permitting issues on wind so hopefully we will have some recommendations so we can get a structure in place. In the offshore did you all look at wave energy at all?

Mr. Wilson: We have looked at it – we did not include it in this plan because again we were focusing on technologies that are really ready to go and that is one where while the concept is sound the engineering is really just happening in the past six months or so that's beginning to prove out sort of how that will actually work in practice. I think within a year or two we are going to be much further along on that issue and we will be able to start looking at it. And that actually addresses the question from Dr. Everett earlier about sort of if you don't do one of these things, what else could happen. Well that is one of the other what else's that could happen. I am very hopeful that that will be an opportunity but we did not want to count on it in this report.

Representative Harrison: Thank you any additional questions? Thank you for that presentation and I am going to turn it over to the commission counsel and he'll talk about in general our recommendations.

Mr. Givens: Thank you Madam Chairman. I've got several things to do and I'll try to do these very quickly. First of all, I distributed to you a one page flyer front and back that is about a symposium that will be held at the Law School at the University of North Carolina at Chapel Hill tomorrow. I think all of that information is there except the tomorrow date. The flyer is captioned The Greenhouse Gas Marketplace: Commercial Regulation of Climate Change Solutions (EXHIBIT K). We sent you a notice of this some time ago and I'll give you the agenda and encourage any of you who possibly can to attend. If you are an attorney it is offering, I think about five hours of continuing legal education and I encourage you to go.

I want to quickly go over the documents that we have given you that I mentioned earlier and also the documents I am giving you now will lead us into the third part of my discussion which has to do with this development of recommendations. First of all as alluded to earlier you have been given five sets of minutes (EXHIBIT G). There's no action on those at this meeting but they will be back on the agenda at the next meeting as an action item. We owe you one set of minutes and we hope to have those to you before the next meeting. You received and all of these documents are in addition to documents distributed in connection with the presentations. I am not trying to inventory them. You received this document entitled North Carolina Renewable Energy and Energy Efficiency Industry Census 2008. Then you received three documents from Tom Peterson, when I mentioned them before I indicated they were at your place and it turns out they weren't and nobody called me on it but I will remind you again what they are. One of them, the basic document is a final report from the consultants about the deliverable under the CAPAG process and what you're receiving there are three documents and these are the big fat ones. There is the final report (EXHIBIT L), that is the biggest one it looks like this and everybody gets one and then there is the executive summary (EXHIBIT M) which looks much the same but it is thinner and then there is the Secondary Economic Impact Analysis of Greenhouse Gas Mitigation Options for North Carolina (EXHIBIT N) which has a white cover. Now you will recall that we've had a presentation at earlier meetings about the Appalachian State Economic Analysis and then at the last meeting we had a speaker who was from the Beacon Hill Institute and who was critical about economic analysis and so Mr. Peterson provides you with two documents – the document from Florida (EXHIBIT F) and the Peer Review (EXHIBIT E) that rebuts the critique. So you have those.

Then I am going to give you something that I have been giving some thought as to what to do and this I think will lead us into the discussion of recommendations. Right at the beginning of 2007 the beginning of the long session, the Commission discussed recommendations to that session to be included in its interim report. The staff prepared an interim report draft but we never formally adopted it, that was at the time when then chairman of this Commission Representative Hackney was transitioning to become the Speaker and we were gearing up for the long session, had major legislative proposals including the REPS and it was simply a bridge too far, if some of you are familiar with the book or movie, to have another meeting to actually get this report approved for dissimilation. What actually happened in 2007 was the focus was on the REPS, which was one of the recommendations in this stocking. I give it to you now for information (EXHIBIT O) in that it has the following in it and because it is a draft two or three of the pages are out of sequence but they are all there and I think it will make sense. It was a graph letter of transmittal which was never executed, a list of members and staff of the Commission from the beginning of the Commission to that time in 2007 authorizing legislation with which you are familiar. A section entitled Commission proceedings which is basically a summary or abstract of the minutes. In other words, it is a short summary of the minutes up to 2007. This is different from the minutes we are asking you to approve at the next meeting which are minutes of this Commission since that time. And then the thing that I think will be of greatest interest to you are those matters that the Commission acted on in early 2007 as recommendations.

When I talked about the extract or excerpts of the minutes we have minutes for all of the meetings period but we are not able at this junction to locate minutes for the last meeting at which the recommendations were discussed. So what you see if you look at that document on page 21 it's just a brief reference of the 22 February 2007 meeting and then the recommendations. Those recommendations span, in my opinion, as recommendations of this Commission and it will be up to you when you vote as I hope we'll get to this time, when you vote on a new report as to whether to include these.

Now as to how we propose to proceed. Co-chairs and counsel met in late October and decided at this point to proceed as follows. We want to spend the majority of the next meeting on the discussion of recommendations and limit presentations to those that are necessary to deal with specific recommendations one way or another. As I mentioned at the beginning of the meeting, I've had discussion since the Co-chairs and counsel met with Co-chairman Garrou, he himself does not have to deal with this issue but as many of you know his wife is the chairman of the Senate Appropriations Committee and we are looking at a three billion dollar hole in the state budget. That has obvious implications for what we can do and what we can expect private sectors to do.

That said the Co-chairs and counsel propose that we start dealing with the following six recommendations. First of all this sets a greenhouse gas remission reduction goal - the proposal according to my notes at the departure point is an 80 percent reduction from 1990 levels by the year 2050 which is the most commonly adopted expressed version of that goal there are of course others. The second one is with regard to a permanent commission to replace this commission so that we would not be extending this from time to time and the permanent commission would have the following characteristics. First of all it would in all likelihood be smaller in terms of the number of members. Secondly it would have a greater legislative representation on it to assure legislative buy in into actions the commission proposal recommendations. Thirdly, it would have some representation or input from the executive branch of the next governor I think will be more interested in these issues than the current administration. I have already talked with the Governor-elect policy people and have been assured that that is the case. For most states that are engaged in climate change, the initiative has either in the executive the start with or at least the executive has a substantial role which has not been the case in North Carolina. Then lastly that there would be a clear delineation and not overlap of the role of a climate change commission with that of ERC which is the long standing legislative oversight and study entity. As long as I am here and my staff and we are staffed to both we can largely take care of that concern because we do staff both. But who knows what the future will bring and part of the question will turn in any event upon whether the commission we are talking about continues to be a legislative commission or become sort of an executive branch commission and what its powers, duties and functions should be. I invite you all to think about that.

One more point, upon reflection it appears that one of the functions of a new commission would be to deal with the adaptation issue. There has been some talk about a separate commission for adaptation – it seems I think our view at this point that a separate commission would be just one commission too many and that a permanent commission could deal with both issues. We hope to prove that point with regard to the adaptation issue and this commission today because we have fine presenters on that topic. The third

item is what often referred to as clean cars and what really involves the adoption of the California Emission and Inspection Standards for motor vehicles. The study of that matter was assigned by the Studies Act of 2008 and ERC. There has been some question about whether ERC will actually undertake that study. It is my belief now that that commission will and will generate a report which probably will take longer than just between now and January to have a robust report that addresses all the issues and that has buy in at the onset by the interested parties. If I find in the next few weeks that that study is not likely to proceed in ERC after all, then that matter can come back to this commission.

The fourth matter is energy efficiency in the state buildings. There was a bill passed in the 2007 session and then revised in 2008 on that subject. I think the proposal here, Chairman Harrison can correct me if I am wrong, but I think the thought is to extend the provision to Senator Cowell's bill that had been enacted to buildings that are constructed with state funds at some level and one of the issues will be how much state funding would be a factor before the requirements would go in. But these would be buildings constructed in whole or in part by state funds that are not state buildings. It may surprise you to learn that the state funds to construction of buildings that ultimately do not own but that is the case.

The fifth matter is some work on making the state building code greener – that's a complex issue and one that is easy to articulate the concept. By greener I mean more energy efficient. Easier to articulate the concept and much more difficult to implement and factor. Lastly, with regard to adaptation, at least as an outset to ensure that state agencies are taking into account the ways in which their global climate change would impact their functions and anticipating those and not only anticipating but making plans to adjust what they do and how they do it to take global climate change into account.

Now I come to this point and this is personal to staff and that is this – it is important that we have in my mind that we have recommendations that are more than just aspirational or goals are important if you want to accomplish something to have an actual plan. But what the legislature can do is adopt laws and we do so to either require something or prohibit something or we levy revenues for the purpose of obviously making money or perhaps for the purpose of discouraging certain activities. We can use tax credits and we can use appropriations – all that requires draft bill language. Leaving myself aside, I will tell you that the people who are assigned to this Commission are among the best bill drafters the legislature has but it is beyond our ability to take 15 or 20, just as a matter of time if nothing else, it is beyond our ability to take 15 or 20 good ideas, well intended ideas and turn them into draft bills. So we need help and if you intend to propose something, please come with something that will help us get started perhaps something that's been done in another state or perhaps something that some outside organization has worked on.

Co-chairs and counsel desires to hear from any of you who have thoughts on these particular matters and how we might best address them at the December meeting. I am in fact looking to you as members of the Commission to assist Co-chairs and myself in putting the next two to three meetings together. We also invite your suggestions as to what particular topics we might look at beyond the six once we have dealt with those six that the Co-chairs have determined that these are where we ought to start. I certainly stand to have any of this modified or corrected or whatever by Chairman Harrison this month and by

Chairman Garrou next month. That outlines our thinking at this point on where we hope to go and that we hope to get this done in time so that we can actually have a draft report with recommendations and legislative proposals that can be submitted to the legislature, if not by the study commission bill introduction deadline, which is generally quite early that it could be submitted in time for the public bill deadline that members can introduce their own bill if not a study commission bill. The language would be the same and they could point to the recommendations of the commissions as a source if they wanted to. That would buy some additional time from a procedural point of view. Of course it would be the sun and the moon and the stars come all together if we had a report on the day the session convened which is I believe the 28th that had all the things you may want in there as proposals and well written legislation. My experience two years ago as we tried to take away from the short interim, its just as easy to think about and say and hope and very difficult for us to do. So we are getting started not in January but in November. I'll be happy to answer any questions and I look forward to hearing responses from any of you. I will tell you in all candors that I've accumulated about 15 hundred document backlog in my email. Ms. Matheson does triage for me so don't bombard me with emails sending me site emails just what you are proposing and we will do our best to respond appropriately as we develop the agendas for December and January. Thank you Madam Chair.

Representative Harrison: If I could just add to what he stated – these are just preliminary goals that we thought would be manageable. We know that there are a lot of recommendations in the CAPAG report. The reduction goal we anticipated interim steps to not just eighty percent by 2050 but obviously we need to start reducing now so we had opted you all to recommend at what stage we need to achieve those reductions. On the permanent commission piece Mr. Givens mentioned that we need more legislators and we're hoping to take advantage of all the expertise that you all have and if you don't fit into the commission we are anticipating setting up an advisory board to the commission. Is that accurate?

Mr. Givens: I failed to mention that piece. We have invested far too much money in the citizen members of this commission not to take advantage of it and so we don't anticipate casting you aside but finding some mechanism and there are models in place for example there is the Coastal Resources Commission which is regulatory commission that has also a Coastal Resources Advisory Commission, a rather large body that is there to advise the regulatory commission. I am not necessarily suggesting an exact parallel in fact I'm wanting to distance myself from any proposal that we create a new commission with regulatory powers, rather that we create more permanent advisory and study commissions that could advise all organs of state government. Right now if there is any trend at all in state government organizations it is toward consolidation and not creating additional entities and I see Representative Underhill nodding in agreement.

Representative Harrison: And finally I was just going to point out that we did talk about green jobs component to this – we were not sure what formula it would take, we talked about it in the context of a greener building code so I am going to refer to Ivan and others who have some expertise in that area to come up with the recommendation on the green jobs but that was part of it. We talked about in the context of building codes.

Dr. Riggs: I am sorry I did not understand what you said about the adaptation going forward with adaptation sub-commission or commission it was not clear to me at all.

Mr. Givens: What I said was that there has been some talk as you know about whether or not there should be a separate commission to deal with adaptation. The Co-chairs and counsel believe and of course, Co-chair can speak for herself and the other in the next meeting, but I'll tell you that the counsel believe that it would be not desirable to try to have two commissions dealing with global climate change but rather one commission study and recommend in a coordinated fashion on both points. Now how that might be organized so that there might be a subcommittee on adaptation that might be appropriate. For this Commission the Co-chairs since the inception of the Commission have chosen not to appoint subcommittees for reasons that they deemed to be adequate. But to solace Dr. Riggs is to have this Commission charged specifically and to place emphasis on the adaptation issue but not to have a separate adaptation entity. Now when telling you all of this I am telling you what I understand to be the thinking of the three of us. That does not mean that you all are bound by that and what you do. These are thoughts about how we hope to proceed as your leaders I suppose. One final observation and this came to me long before I went to law school and long before I came to the General Assembly, it has been my experience that it is a bad idea well written will beat a good idea that's just a thought every time. The most powerful thing is a good idea, we are good writers but we have to deal with lots of things. Mr. Hudson, Ms. McGinnis and I are trying to solve solid waste issues, water allocation issues, Stanley County and Alcoa issues, in other words we have a lot on our plate. We have a lot of expertise in the bulk in this room, we don't have enough lawyers I suppose but that might be a debatable point. At any rate we solicit your help in getting the work with this Commission in going forward. Thank you very much.

Mr. Stevenson: Thank you Chairman Harrison. I wanted to thank you for bringing forth the interim report. The interim report is primarily based on CAPAG recommendations and some recommendations from the Commission members from I guess the early part of the Commission up until early 2007. I think that is the last date I see in here. There was a product that Bill Holman produced for the Commission, which I believe was earlier this year and it chronicled a series of potential adaptation recommendation that we might want to bring back before the Commission in a future meeting.

Mr. Givens: OK we'll take a look at that. What I was trying to do is give you what I had to work with. I had several request and Ms. Tompkins had asked about the minutes or some other documentation about the recommendations that were previously adopted so I gave you the best evidence of what I have.

Representative Harrison: OK well if that is it we are going to break for 45 minutes and come back at 1:30 and hear the presentations from the folks on adaptation. I hope all of you will be able to make it back. We did not anticipate needing a break for lunch but we've gone over so thank you all.

<u>After Lunch</u>

Representative Harrison: We are going to try and get started on the second half of our agenda. We've had several people come in from out of town and we're going to cover them first. Sam Pearsall who is local will come back when there is a bigger audience but at this point I am going to call on Michael Bryant who is here from Fish and Wildlife Services. Thanks to the rest of you all for coming back.

Mr. Michael Bryant: I am with the U.S. Fish and Wildlife Service and my presentation as you can see from the first slide is talking about adapting to change. I am a land manager I want to let you know first who we are as an agency, what we do, who care about what we do, what we're seeing happening on the land today, what we are feeling we are likely to see in the future on the lands that we manage and what our potential responses to that will be and that's the adaptive part of this. And who could potentially be doing that with us. National wildlife refuges are managed by the U.S. Fish and Wildlife Service, they are federal lands and so our job is to be land stewards when problems come like climate change and if we don't get up and leave we are fixed to the lands. It's the land that we manage, there are over 548 national wildlife refuges in America and there are eleven in North Carolina. We consider land as a community of life and to us is what an eco system is. Wildlife lands and the perpetuation of diverse and abundant wildlife to us are essential to the quality of American life that we are public servants. So we owe folks hard work, integrity, fairness and a voice in protection of their natural resources which are entrusted to us to conserve. We are not a hands off agency, we manage as necessary and if the management we do on our lands range from simple preservation to very active manipulations of the habitat and the plant and animal communities in order to achieve our particular mission. And that involves any number of management practices that I can point to a little later in the presentation and we always welcome and feel that it is essential that we have partnerships for the mission of the Fish and Wildlife Service starts out with the words working with others. Who cares about refuge? Well in 2006 in relation to the issue of global warming, defenders of wildlife came out with a report called Refuges at Risk and they identified what they felt were the ten most endangered national wildlife refuges in the nation out of those more than 500 refuges and from this particular slide you can see that in North Carolina, Alligator River National Wildlife Refuge amongst all the refuges in the system is the one they've identified at risk due to climate change.

In North Carolina in the Coastal Plains there are ten of the eleven wildlife refuges, one is in the Piedmont. Those ten as you see in the red cluster in the lower Coastal Plains in the northern half of the Coastal Plains of North Carolina. On the satellite image you can see where those refuges are located. I manage six of the nine refuges that are entirely within North Carolina. I agree there are some swamps which is in the upper left of that slide is managed out of a different regional office in the northeast because more than half of that refuge is in Virginia. But you can see from this particular slide as I'm coming down closer and closer to where the refuges are and where the issues are attended to climate change as it affects these lands that we manage. There is an awful lot of water where ever there is this land that we manage, it is part of the landscape as a dominant feature in the landscape and will affect this landscape significantly.

One of the refuges I manage is Pea Island National Wildlife Refuge and this is Oregon Inlet and this starts to speak to what we see happening today and what we've seen happening to

one particular refuge and then I'll speak later about Alligator River National Wildlife Refuge. And why I start with this one is the Atlantic Ocean, that big body of salty water sitting there and its few inlands into the estuarine system, the sound system will affect all of those lands inside that barrier island system as that barrier island system changes. As you turn and start going south the way one of the migratory birds that we manage for on Pea Island, you start to see from the air, one how narrow this landscape is, how dominated it is by water and if you look at all the tan sand that is sand moving as a natural course of the coastal process that work in this landscape as sea-level rises, as storms come and if we have more storms and they are more intense, we will see more of this.

Now from a National Wildlife Refuge standpoint and from a wildlife habitat standpoint, when the ocean feeds sand up and over this island that is not necessarily a bad thing, that is creating habitat, that's restoring habitat. Often where you have a natural process and you can allow it to dominate that landscape its sometimes very beneficial to the wildlife that we are trying to manage for. This refuge established 70 years ago was nearly 6,000 acres in size, today it is less than 5,000 acres in size. It didn't have a highway through it until the 1950's it didn't have a bridge to it until the 1960's. With highway and bridge and a landscape that is in constant motion you can perceive that it makes it much more challenging environment in which to manage for wildlife first and it also is an environment that is very challenging for the Department of Transportation to maintain infrastructure. If you look at a double set of power poles one standing in the sand near the beach and the other one starting to appear on the other side of the highway, so that is the typical progression of what is happening on that landscape from an infrastructure standpoint. Power lines are being moved to the west of course you are going to run out of land from that picture pretty soon to the west. Highway has been moved where you see these little curvy jogs, that are where the highway has been moved in the past so they are going to run out of landscape even if we allow under regulations to permit them to move the highway. But from a wildlife standpoint what we are doing here is managing for migratory birds and other species like sea turtles while this change occurs. If you are looking from the south where the refuge ends 12 miles south of Oregon Inlet, looking north you can see the interface between the National Wildlife Refuge and the community. And in 2005 this was the way it looked immediately after Hurricane Isabelle. Now again all of that sand moved across the landscape trying to get across to the sound side – in a larger storm, sand would have moved all the way across and in a few spots it did. And it will build islands on the left of this picture in the sound if you let that occur over time. In the face of development though it is very difficult for that to occur because you have to restore the highway, you have to restore and you do that by getting the sand back into the active zone where the ocean is. And there is the challenge in managing for migratory birds and other kinds of wildlife in this kind of environment.

This same spot just a month ago with this house that you can see right there – that's a house standing with beach in front of it after Hurricane Isabelle. Now go to the next picture and that house right there is that same house with far less shoreline, ocean going under during a minor low front that came through (inaudible) the Outer Banks in mid October. You can see the landscape changing rapidly, there is a house right there that fell in but this shoreline is regressing toward infrastructure that's fixed. And that is a challenge for society. Yes.

Ms. Tompkins: (Inaudible) on what term the weather was?

Mr. Bryant: It was a low pressure.

Ms. Tompkins: In October?

Mr. Bryant: In October – and typically if these last any duration and have winds above a certain speed they are called a nor'easters they didn't call it a nor'easter because it did not quite reach the nor'easter strength but it doesn't require those strengths of storm any more just duration sometimes now especially on a full moon or new moon. It gets the tide up enough to start putting it across the dune system and into the highway. Now that same house and obviously the response again I am putting it here because there is a sign for the refuge going north into the refuge. This is National Wildlife Refuge this is the first community south of it. This is a highly vulnerable spot that everyone has to consider as they adapt to this change of sea-level rising, more frequent and more intense storms and an environment that is shifting dramatically.

Representative Underhill: Excuse me is that a community that has a name?

Mr. Bryant: Rodanthe and this is just the last picture looking all the way north into the refuge – probably the first six miles of the refuge north and the road jogging along through getting precariously close to the ocean and all of this is good wildlife habitat for a variety of migratory birds. Again for which and that is why that refuge was established in 1938 and our challenge is to continue to manage it for the benefit of wildlife and for appropriate wildlife dependent recreations and it is becoming more of a challenge obviously. I am going to jump now we've got the Atlantic here contributing salt water to a sound system. I am going to jump across the sound to Alligator River National Wildlife Refuge. Alligator River National Wildlife Refuge is most of that peninsular although 46,000 acres of that peninsular right in the middle of the square is the Department of Defense land and there are few communities (inaudible) Tarboro, East Lake and Stumpy Point that are adjacent to that national wildlife refuge. This is Roanoke Island and there is Oregon Inlet and that is where we just were on the picture. Now this landscape that Alligator River is in is made up of a variety of habitats. The Pocosin habitat is a name that predominates this but there is marsh and it's a freshwater marsh that overtime will convert to a salt marsh as the sound becomes saltier. We have low shrub pocosin, some pine soil pocosin, an Atlantic waste seeder and have Gum and Cyprus swamp all on this peninsular here as well as across Alligator River on other lands that aren't part of the refuge. That gives you a flavor for the variety of habitat sites that are there and that's what supports the abundance and diversity of wildlife that is there. Again it is the national wildlife refuge set aside for wildlife and for appropriate wildlife dependent recreation and what is happening in that landscape is this: we acquired the land with the help of conservation and nature conservancies over time. Everything in green is refuge there is the (inaudible) range – but you can see it dissected with roads. Every road there has a ditch beside it – every ditch allows water to move quickly in and out of the refuge where historically water sheet loads off of it or rained on or came in slowly across the landscape as the sound would rise and flood. When you have a distance and you let water jet into the system and also on tide events let water run out quickly it gets

fundamentally altered in the ecosystems. Underlying all of this is a very rich and broad organic soil base so there is a lot of peat soil here, a huge carbon sink and in these pictures this picture here is a ditch that has been widening all by its lonesome and it is right here near the sound with water penetrating and leaving it frequently because it is so near the sound and that water is becoming saltier by the year and it is a combination of being in proximity to the sound as well as the salinity of those waters that is killing back vegetation, decide lining the banks causing the ditch to widen and changing the vegetation community. The other picture shows an interior of this that hasn't widened over time because it hasn't been influenced by these same factors of the salt in the water and rapid intrusion and exit of water.

There has been a number of models run to show what would happen to this landscape, there is Alligator River, this is the Albemarle-Pamlico peninsula and over a course of 100 years you get a 32 inch sea-level rise. Look how much of the landscape becomes open water. So we have a vested interest in trying to understand what's going to happen. And as managers we have a bias toward action. I mean I am a land manager so I want to do something and I plan to do something and I'll do it with the best available information. And what I need to do in the face of this kind of forecast is to look for ways to make that landscape resilient to it. One is to help slow down that intrusion of that salt water and these kinds of effects with salt water coming in that changes whole vegetative communities. The biologists that work for me that have been at work in this landscape for more than 30 years can easily point to tens of thousands of acres when they started their careers that were forest that are now marsh. Through no action of our own, nothing we've done just watching it happen you have forest and stress. When a forest gets stressed it is vulnerable to things like beetle kill – this is southern pine beetle which will kill pine trees by the thousand. Now what stresses the forest can be a storm event, it can be water being too high and in this case we are seeing southern pine beetle infestations that are killing forest and we have to go in and manage that to try and prevent the spread of that. What we have in this rising sea-level scenario are changes in the vegetative communities, increase in forest health issues, and also when you have the soil exposed after the vegetation dies, a loss of carbon the soil itself and what we want to get back to is a no net loss of that soil. The soil and the water are the foundation for the ecosystem and for growing plant communities that support the wildlife population that we are all about.

What kind of adaptive management strategy should we consider and have we considered? Well one, since we are land management practitioners we have a lot of practice as we employ now and always have. We use fire, we put fire out but we also do control burn. We manage water levels, we do it primarily in impounded areas for trying to increase the food availability to water fowl in the winter. We do farming with coop farmers to increase the amount of high energy food for water fowl in the winter. So we very actively manage this landscape and now we need to know what are we going to do with our skills (inaudible) and where are we going to do it to make this landscape more resilient to this sea-level rise that is occurring. What is causing it that is not my debate, it is happening, it's measurable and it's likely to continue to happen. I as a land manager should do something to work toward resiliency in this landscape. Things like water control structure – where we can use fire and judicially we put in fire breaks and use in fires. Things like replanting plant communities – these are the kinds of strategies that we want to consider and consider where we can do it

with the help of our partners. Some of the conservation tactics can include both on refuge and adjacent to the refuge are hydrologic restorations, which we've been trying to do since this refuge was created in 1984. However, we are doing it on a boot strap style and not with a lot of general science, just our best understanding of where we should move water control circuits in to limit the amount of water penetrating the refuge and slow down the exit of water so we can get it running across the landscape again. But with more science we can figure out better places to put those water control circuits.

Now land restoration and reforestation and shoreline transition work, those are some other things we can do on the refuge to make that landscape more resilient. If it is going to erode away we want it to erode away at not an accelerated pace because of our lack of management or because of previous management. We need to do things to bring the rates to a rate that is manageable and try and influence the pace at which it happens. Something that is being considered by one of the state agencies and some of the nonprofits, putting oyster reefs adjacent to those shorelines to break down the wave action and also to create better water quality from the action of the oysters in that water adjacent to the refuge. The other thing that is very important in management is measuring – we have to measure and monitor what we are doing otherwise people will challenge us always on what we do and they should. And if I haven't got good science then it is my best guess and often I have to manage based on my best guess because again my bias is to act not just to wait and worry. I take action on the best available information I have. But working with experts and developing strategies to understand what is happening to the soil and what is happening to the plant communities will allow us to better decide where to do what and what to do.

Some of the people that we've been working with and entities are the North Carolina Chapter of the Nature Conservancy, North Carolina Coastal Federation and there are potential partners in this exercise obviously, but this is a landscape level effect and in this landscape you have over a half million acres of conservation land, that is not all refuge. I manage six refuges they add up to about 300 thousand acres but you have state agencies that have large holdings on the Albemarle-Pamlico peninsula. You have nonprofits that have large land holdings so you have an opportunity with a landscape this size with so much land in conservation already to pilot adaptive management practices on that land in a way that could be measured and monitored and then you can learn from it and come back and say to the greater public here are ways we can manage in the face of this sea-level rise. Not just sit back and go oh my God what do I do? What we can do is make this landscape more resilient. What we can do is start to plan and look toward the future where would be the next place to consider additional conservation limits as these lands go under water because there will still be a need for land for conservation, there will still be a need for habitat for wildlife so we have the abundance. So we need to start planning for those things while we're managing (inaudible) for what is coming now. That is essentially my presentation if someone has questions I would be happy to take them.

Representative Harrison: Thank you. If I could ask what is the status of the bridge, isn't there a proposed bridge alternatives, one was a causeway and one was more of a fixed point?

Mr. Bryant: North Carolina Department of Transportation and Federal Highway Administration are concluding their National Environmental Policy Act process. Their final EIS came out last month or maybe two months ago the comment period ended last month. DOT's schedule is to go to a record of decision on that in mid December and their schedule is to let a contract for designing and building a short bridge across the Oregon Inlet next year with construction starting the year after as I understand it. So from the current preferred alternative they have is to build a short bridge next the Bonner Bridge right back to essentially where the Bonner Bridge makes land fall on Pea Island now and then over time their plan is to build additional bridges in the existing right-of-way as conditions warrant or demand. So in that plan if it is played out completely there would be ten miles of bridging over the 12 miles of refuge. It would exist where the road does today except the island would be moving out from under so that bridge could ultimately be in the beach base or in the surf zone of the island if the island keeps shrinking, moving and breaking from.

Representative Harrison: So the design would accommodate that migration?

Mr. Bryant: That is I think the reason for bridging. They had an engineering group come together and say what is feasible and they said well that is feasible from an engineering perspective.

Representative Harrison: Any other questions? Thank you for making the trip and next up, Sam is going to present at the next meeting, Dr. Reide Corbett and Dr. J. P. Walsh from East Carolina University (ECU). Thank you for your patience.

Dr. J. P. Walsh: Thanks for coming back after lunch. It is a pleasure to be here. I am J. P. Walsh and I'll be talking with you today along with Reide Corbett who will be up in a minute and we'll be talking about estuarine shoreline erosion and coastal hazards in North Carolina. Just to give you a little brief background about myself, I graduated from Colgate University in New York State, did a master's at Stony Brook on Long Island, did a PhD at the University of Washington and I was a post doc at Scripts Institute of Oceanography in California. I am an assistant professor at ECU. I am joint appointed between the Department of Geological Sciences and the Institute for Coastal Science Policy and basically my interest is understanding land-sea interactions and to use a variety of tools for doing that and have done work not only in North Carolina but around the world.

There are a number of reasons why we care about how climate change can impact North Carolina coast. Obviously one of the key reasons is that North Carolina much of eastern North Carolina is very low lying and that is what this map on the wall shows. The areas in red are an elevation less than two feet. Also coastal North Carolina is obviously an important economic engine for this state. Additionally there are critical sensitive habitats that occupy this coast as Michael Bryant just talked about. In particular we are going to be talking about estuaries some today. Estuaries are coastal water bodies where fresh water and salt water meet and mix so they typically have a brackish salinity. Why do we want to plan for climate change and coastal hazards in North Carolina? Well obviously as I've already said, it could be that coast is a critical economic engine in particular the tourism and fisheries industries are very important and can be impacted by climate change. Visitors to coastal counties spent over 2.5 billion in 2007 and which is a significant percent of the

tourism dollars coming into the state. Obviously some changes can have some major impacts on the infrastructure and so we need to plan responsibly so that we deal for the potential changes. Shown here is just a figure showing a perspective view of North Carolina and on it I've indicated some of the coastal hazards effecting North Carolina, the first four indicate some of the basic ones that kind of occur across the landscape. Shoreline erosion, storm surge, water quality deterioration and inundation by sea-level rise are things that are sort of ongoing across North Carolina. There are two other specific hazards that I'll be talking a little bit about today, over wash and inlet opening potential which are risk to the Outer Banks specifically.

Something of course to realize is that the risk to coastal hazards and to sea-level rise, in particular, are getting worse, not only because of sea-level rise but also because of population growth. Right now the coastal counties are home to almost a million people, a million North Carolinians and then the last three decades some coastal counties have experienced 75 to 150 percent population growth, so very impressive growth rates. Some of the work I'll be talking about today by researchers at ECU was basically supported with cooperative work between the U.S. Geological Survey (USGS) and others at the University of North Carolina and other universities. There was a major initiative to understand the ecological impacts of sea-level rise which was supported by NOVA and then support from the National Science Foundation, from the UNC systems, the Renaissance Computing Institute in North Carolina and ECU itself has provided additional support for some of the work. We use a variety of tools we go out into the fields and take cores and use geophysical methods to map and look at the geology and the processes affecting the system and then we tend to process that with a variety of computer software etc. I will not get into those details.

As we all in the room are well aware that climate is changing and it is causing other environmental consequences and that is really what I will be focusing on here today and Reide will talk about as well. Shown here is the global average surface temperature and you can see that rise significantly since 1950 and then we can also see the global average rise in sea-level which is a significant consequence of climate change. Some other consequences that I just want to mention are changes in storm frequency and intensity which I will briefly talk about. Of course droughts, floods, land habitat, land and habitat losses which might be induced by either of these processes that I've mentioned. Of course with ecological effects such as fish kills or other ecological changes Michael just mentioned things like pine beetle infestation and there certainly are others in the marine setting that are a problem. And of course these things can have significant economic impacts in terms of land loss not just loss of property, direct impacts to infrastructure as well as some indirect things like impact on fisheries and the economies that the fisheries support.

Some work that researchers at ECU have been working with people around the country in particular from the University of Pennsylvania has been trying to document the rate of sea-level rise in North Carolina. One common approach is to use tide gauge records but tide gauges in North Carolina have been sort of only around for a short period of time and therefore can't really be used to look at sea-level rise and so we need to use the geologic record to do that. Basically, I will not get into the details, but they use the shells of organisms that live in the sediments and then from that record we can construct what the

sea-level curve looked like and that's just what is plotted here. This is a plot of wealth at sea-level and then time is on the x axis. And what you can basically see is that rate of sea-level rise has increased dramatically in the last several hundred years. I guess you all are familiar with the global warming hockey stick curve – well Dan Horton and Reide Corbett and others have talked about how we might similarly see a hockey stick curve for sea-level rise and it does appear that we have that occur in North Carolina.

Storms are a critical sort of perforation to the system and the sea-level should mention a sort of chronic process. It is slow and steady and it is hard to sometimes understand what the potential impacts of sea-level rise are. Storms are sort of the (inaudible) acute event that really drives the point home that we are living in a dynamic system. This is just a shot of Hurricane Katrina – some of the satellite imagery that shows this moving ashore. We've obviously also had major hurricanes impact the North Carolina coast – the work that has been done recently suggest that there will be more frequent intense hurricanes. In the upper right hand corner is a graph of the number of cap 4, 5 storms as is predicted to increase with time. I don't want to get into the science of storms or sea-level rise too much other than just to emphasize that these are sort of critical consequences of global warming.

One of the great things about North Carolina is we have an impressive amount of intellectual capital in this state. We have expertise on a great number of key things that we need to know to really understand how to respond or to adapt to climate change and shown on the right is a bunch of the logos from all the players involved looking at various aspects of coastal dynamics in North Carolina. This is meant to be sort of a (inaudible) way side to mention an initiative that some of us at East Carolina have been working on is a website or what we call the North Carolina Coastal Hazards Decision Portal which is a website where we are trying to bring together some researcher information on coastal hazards including sea-level rise. This website will include a brief review of the coastal hazard information as well as provide publicly available information like hazard mitigation plans, also we will give tools. So number two is to create tools to enable the public to understand and view some of the hazard information in a frame work that they are used to and then also to provide for Reide's brief explanation and understanding of some of the natural science and social science aspects of these hazards. I'll give some examples just to let you understand a little bit more of what I'm talking about. Shown here is just a snap shot from the web page actually one of the handouts that you received gives you the website location, a little brief news release, we've had a few articles written about the website and have gotten some good attention in the press recently. So I encourage you to go visit that at your own time.

I want to give you one example of one thing that is featured on this website and a real hazard facing North Carolina that we've done some work on. Inlet opening potential is a real hazard we've talked about earlier, we showed some pictures of (inaudible) area – well as some of you might be aware during Hurricane Isabelle in 2003 we had an inlet that opened on Hatteras Island which is what is shown here. The Army Corp came in quickly and closed up this inlet but the fact is the Outer Banks are a narrow strip of sand that is very much because of the limited sand supply and the energetic coastal environment is at risk to future inlet openings. Shown here is a map of the active inlets those are indicated in red along the Outer Banks and yellow are the historic ones. They were not opened all at once but give you an idea that in the past we certainly have had inlets in much of the Outer

Banks. Stan Riggs and others have shown that very large percentage of the Outer Banks at one time was occupied by an inlet. So one thing we have done to sort of quantify the potential risk to inlet opening is just to use some lighter which is elevation data that was collected as part of the state flood plain mapping effort. We used that to quantify some aspects basically the volume of the Outer Banks and then from that information we can identify risk areas along the Outer Banks and that is what is shown in this figure. Note in this figure the area where we have low volume which is the graph off to the right. Right here is where we had an inlet opened during Hurricane Isabel in 2003. So it is a very simple approach to identify risk areas along the Outer Banks. When we take this approach and apply it along the Outer Banks we can identify the very high potential areas and you will notice in red on the right here are areas that are very high potential for opening inlets and the black circles indicate where we've actually had inlets within the last century. So it is sort of an approach of predicting possible inlet opening places and works fairly well.

So we've created this data set and now what we've done to share this with the public is we bought this into something that many of you are probably familiar with. Google map which provides a nice background data set of aerial photographs and a user can go zoom in and zoom out, they can find their house, they can find their favorite beach and look at the potential inlet openings along the coastline. This is one example of the tool that is available at this site. There has also been some other socio-economic work looking at inlet opening potential and this is also available on the site. Some work by Hans Volgleson at ECU calculated what the cost per day for having an inlet open at the different sites indicated on the map and the cost basically using some simple assumptions range from a million to five million dollars per day. So there are some significant economic ramifications of the inlet openings. One important reality that we hope to keep the reality of storms and sea-level rise in the forefront of people's minds and so we created another tool to sort of allow people to understand the impact. Other than what's shown here is just for loading up images of past hurricane impacts and people can go and look at what happened during hurricanes of the past to allow us not to forget. Another tool that has been worked on, I'll just mention briefly, is ocean erosion. Shown here is a graph of it – the Division of Coastal Management has worked hard to map our ocean shorelines and from those mappings that we've determined ocean shoreline erosion rates and those are the basics of set back policies along the Outer Banks. What we've done is taken those data and sort of projected the rates to allow people to understand where erosion might occur in the future. This is a big leap of faith I'll admit but allows people to sort of put the erosion in some perspective of the home owner along the Outer Banks. We also intend to look at how recent ocean shoreline rates might compare with those historically. This is something that obviously we need to deal with and understand particularly as sea-level rises. We certainly anticipate that the shoreline erosion rates both in our ocean and in our estuarine areas will change with time and Reide will talk a little bit more about estuarine erosion in a second.

Last I just want to mention and give you an example of a sea hazard that potentially will get worse with sea-level rise, climate change will not only cause sea-level to rise but may increase the number of intense storms. Katrina obviously provides an impressive example of what a major storm can do. The state of North Carolina needs to be prepared for the arrival of a major hurricane. It is not a question of if one will hit us it is a matter of when. We need to basically adapt and prepare a plan for the future not just what to do immediately

in terms of how to evacuate and how to respond but also once we have a major event how do we deal with the infrastructure and the property that is destroyed. Do we rebuild in places that are identified as being dynamic and dangerous? Sea-level rise of course is going to magnify the impact of these events because again we are talking about a very low elevation with low (inaudible) and when we have a storm the coastal areas of North Carolina are particularly vulnerable.

I just want to show you some images of what happened to a barrier island in response to Hurricane Katrina. What I'm showing here is some (inaudible) data that is laser detection in ranging and is basically a tool that we fly from a plane that sends out lasers to the ground. And from that we can get the elevation of the ground and basically what is colored brown in this image is a barrier island and what is colored red and green are houses and that is what I've indicated. This was data that was collected it was from Salty Islands, Alabama and it was collected pre Hurricane Ivan. I should acknowledge the USGS for these data. So this is post Hurricane Ivan – Ivan was a major hurricane that made land fall in this area. There were a few houses that were lost in response to this event. I will not bother pointing those out but what happened is this is after Hurricane Katrina and as you can see we lost much of the structures across this barrier island. Just to send this picture home a little bit, this is the aerial photograph from that exact area, so obviously major hurricanes can have a real dramatic impact on barrier islands and we need to be aware of this potential risk. I do want to highlight here that Salty Island has different characteristics from the Outer Banks. The susceptibility surge is different but there certainly are tremendous risks to the Outer Banks to a major hurricane as well as the rest of the coast of North Carolina I should point out.

Just to give you a larger perspective I was showing you one area – this red in the top figure indicates houses that were lost. Also I want to point out that the red indicates erosion of the barrier island and the green indicates deposition. As Michael pointed out in the previous talk this process is a very natural process and it is how barrier islands respond to rising sea-level in storms and this is a natural process that it is going to do this. Unfortunately, we have a lot of infrastructure on the way but we need to be aware that this is something that is going to happen and be prepared for it.

Now I am going to pass this talk over to Reide Corbett.

Dr. Reide Corbett: This is a quick introduction. Again, my name is Reide Corbett – like JP I am an associate professor at East Carolina University in the Department of Geological Sciences. My background is actually in chemical oceanography and I do a lot of work nutrients and sediments dynamics primarily in North Carolina but also around the globe. You have already seen this image and I start with this image, what I am actually going to talk about is estuarine erosion, but I start with image clearly Mike and I have spent hours on our website. Because it really demonstrates the impact of sea-level rise on the ocean front it is very easy to see the Atlantic Ocean encroaching along our barrier islands. Michael had mentioned that the one house that was falling into the ocean - this is a very common site and this is the sort of images we see during major hurricanes and after major nor'easters. This is very common along the Outer Banks. And again the same image that Michael showed earlier where those hopeless romantics in the recent movie Nights in Rodanthe, that is that romantic house that is now being taken over by the Atlantic. Certainly our

coasts are being encroached by the Atlantic but (inaudible) way into that with the idea that when we think about our coast line along North Carolina many of us think about the ocean front. The fact is that the majority of our coast line is actually found along the estuarine shoreline. Although much of the Atlantic front is what we think about when we think about coast lines. It is somewhere between four to twelve thousand miles of shoreline that makes up our estuarine shoreline. We have very little understanding of how that shoreline is changing in the near future associated with sea-level rise and associated with much of the climate change and much of the global warming that is expected in the near future. I start with a few images of what the shoreline looks like, the different types of shoreline along the estuaries and these have been mapped out fairly early in the 70s and 80s by Stan Riggs. Trying to get an idea of how these shorelines are changing in the face of sea-level rise and so I am going to show you four different images of the different types of shoreline. This is a low sediment bank and each one of these you will note that it is fairly easy to get an idea that these shorelines are retreating. You will see ghost forest (image C), you will see some dead trees of ghost forest (image A), you see an agricultural land affected by these rows are being cut into by the estuary. Here is a high sediment bank. These obviously eroded very quickly and fairly dramatically during major storm surges that we can have and happened in Hurricane Isabel along the Chowan River where we lost up to 100 feet of one particular bank during that one storm.

Swamp Forest shorelines along fresh water systems - again you see a ghost forest in that top image and some of the most critical habitat are marsh environments or marsh platform in the saltier regions of the estuary. And again critical for the ecology of the system are fisheries, are shrimp or crabs and our other fisheries in the state. The key for water quality sustaining decent water quality in our estuaries, these are systems that are being lost fairly rapidly and that is what I will try to demonstrate today. The other interesting thing in our state and around the Atlantic and Gulf Coast is our shorelines are being bulk headed at a fairly rapid rate. The structuring and hardened structures are being put up fairly quickly within the estuarine environment with very little guidance of what can and can't be placed along the shoreline. This is an area that I think we really need to keep our eye on and do something about fairly quick so that we don't end up with potentially a very large bathtub that is going to be filling up with hardened structures along the entire shoreline. I show here a few images primarily from the Neuse River estuary where we have done most of our work. This is out a little further north within the system along Roanoke Island again showing some of the filling and hardening and of wetlands basically lost of some of this critical habitat and the associated development that comes along with some of the loss.

So I am going to focus on primarily the Neuse River estuary shown there in the yellow box and this is an area where we focused the last roughly three years of some research by NOAA and some of what we are really focused on is what the rate of sea-level rise and you've seen some of that in what JP just showed with some cores that we've collected using the geological records to really evaluate what the relative sea-level rise is here in North Carolina. And some of the impacts that that might have and evaluate those impacts, how, where and why shorelines are retreating and I am not just looking at the shoreline. So where the water meets the land but also the habitat sitting right at that shoreline, we refer to it as shore zone. Whether it is that marsh or the marsh transitioning in the forest how has that changed with time? When we think about sea-level rise on any coast particularly along

the estuarine shoreline there are many things that are happening. You have for instance this is showing a marsh environment that is transitioning or migrating up that interface into a forest. That is where you get this ghost forest in that transition zone. The marsh migrating into that forest associated with the rising sea-level. At the edge of that very edge leading up to the landscape you have the erosion of the shoreline. We are looking at all of these processes that I show in this particular picture, we are looking at the shore zone migration we are looking at the incretion of a marsh and how that changes with sea-level. Many maps that you see are simply flooding maps with flooding the landscape as sea-level rises. Some landscapes like many marsh environments do keep up with sea-level rise, they may erode back but some of those marshes will also increase with time keeping up with sea-level rise. Then you have shoreline erosion. In dealing with shoreline erosion especially in these marsh environments, you have a significant loss of habitat and one critical habitat would be wetland habitat because of its functionality. Improving water quality through various filtering mechanisms obviously is critical habitat for fisheries. And what we've seen especially during Hurricane Katrina and within Louisiana recently is the importance of these marsh environments for helping and protecting the landscape behind those marshes as far as buffering storm surge. These wetland habitats are critical for many reasons.

I don't want to get into too much detail with the actual methodology but to give you some idea of what we did in order to get the data that I'm getting ready to show you. As we look at two different time periods – we looked at aerial photographs from 1958 and 1998 and essentially what you see in this particular image are those two digitized shorelines. The green line along the coast – this is just a small image of Cedar Island and the green line represents the 1958 digitized shoreline and the orange line represents the 1998 digitized shoreline. We can take that digitized line and convert that to points and essentially subtract the points to a difference. From that difference between 1958 and 1998 those 40 years we can look at erosion, we can look at incretion of land or we can look at ultimately no change on the scale of about, these are accurate within at least a foot if not better. So these are two different images showing the 1958 aerial photograph that we used and the associated digitized shoreline and the 1998 (inaudible) again aerial photograph and the digitized shorelines. We've taken those two shorelines and essentially done a difference. This is the Neuse River estuary including the Cedar Island area and what we've looked at is a 40 year change in shoreline.

I am going to focus in on just two locations Pine Knoll Shores, Cedar Island and again the focus area was primarily the Neuse River estuary but associated with some of the other work that we had going on we also looked at shoreline change in Roanoke Island. We looked at shoreline change in Pine Knoll Shores and I'll just compare some of the information from Cedar Island to Pine Knoll Shores and give you an overall figure of what we saw. Cedar Island and Pine Knoll Shores are very different systems, both sounds, fairly narrow, don't have a whole lot of area for waves to pick up. There is tidal fluctuations on a daily basis where Cedar Island you have very little tidal fluctuation, you have a very large fetch or you have a very large area where you increase winds increase waves. My focus first on Cedar Island and just kind of give you an idea of what I'm going to show you in the next several slides. The next several slides will show an aerial photograph and on that aerial photograph notice there are several different color dots that line the shoreline. Those

dots represent a rate of change along that shoreline for those 40 years. So in this case if you see a green color that's very little change – somewhere between 0 and 0.5 meters per year of change, if it is green 0 to 0.5 meters per year erosion. You see the blue color that's land gain you're creating, if you see the yellow, orange, red that is land loss, erosion. And as you move to red it's eroding much quicker. Just a quick assessment, you can see that the head lens tend to be higher in erosion. Here a lot of the area tends to be in the green so this particular area had an average shoreline erosion rate of about 0.225 meters per year. Just under a foot per year lost of land for Cedar Island.

We go to Pine Knoll Shores and the interesting thing about Pine Knoll Shores is a very short stretch that we actually looked at. If you just get the average change for that entire shoreline the actual change is 0. Very little change on average, now there is quite a bit of variability of the actual change and it ranged from some incretion as much as 2 meters per year. We were actually gaining land in this area particularly marsh to a loss of about a meter per year. Quite a bit of variability between what we are seeing within the small stretch averaging out to very little change, probably associated with the fact that we do have major tides in the system and we do have fetch for increased wave activity. If we look on a very large scale as this is the entire image of the Neuse River estuary the shoreline that we actually digitized and looked at shoreline change. And again what you see is a point every 150 feet along this shoreline. That point has been color coded based on whether you are eroding land or gaining land and again eroding is shown in the warmer colors your yellow and red. The fact is that we have great variability in erosion rate some as high as six to ten feet per year erosion along that shoreline. It varies depending on many things, fetch for one whether that shoreline has been hardened or not, what the chemistry is, what the depth profile is as you move off that shoreline. There are a lot of different parameters that can change how quickly that shoreline erodes over time. If you want to just look at some general trends you can focus in on what the trunk of the estuary looks like. So this is just reducing that data set that's just the trunk the main tributary of the Neuse River estuary.

What you see is the majority of your colors are much warmer colors. You have much more erosion along the trunk. You have higher erosion rate primarily the further you go out into the estuary, the closer to the mouth of the estuary where you have that very large fetch associated with Pamlico Sound. As you get closer to New Bern further up towards the con points of the river with the estuary notice that goes to your cooler colors, your greens and yellows. Smaller fetch not as much room for wave activities and slower erosion. We make this comparison to the main trunk of the estuary to maybe a few of the actual tributaries. So I am going to focus and just give you a couple of quick images of these three tributaries. One is the confluence of the river and the estuary right at New Bern this is a Swamp Forest environment. The one at Broad Creek just the next step down and then Cherry Point. Those are the three sites going from left to right again is the Swamp Forest at New Bern, Broad Creek and Cherry Point. Notice most of the colors in each one of those are green, very low erosion rates occurring within the tributaries especially when you compare that to the main trunk of the estuary. Now with that it is important to understand what's happening along most of the coast line, this idea of shoreline modification. When we started doing this study we were doing it primarily was aerial photographs and of course we wanted to get out in the field to kind of ground (inaudible) much of this data and when we did we noticed how important it appeared to be that shoreline hardening was becoming along our shoreline. So

we actually went out with the laptop, we went out with the GPS system and we mapped all of the hardened structures along the trunk of the Neuse River estuary. What this shows is each point represents an area where you had some modification of the estuarine shoreline. You can see the kind of laundry list of different types of modifications that we were actually looking at from a boat launch to a bridge to rip rap to ruin structures to an actual bulk head.

What is interesting is if you take all of this just along the trunk and compare those areas that are hardened versus those areas that are not the table in the upper left gives you some idea of the summary of that. Roughly 30 percent of just the trunk, ok this is just the trunk of the estuary, 30 percent of that trunk has been hardened or modified in one way or another primarily by vertical structures. So that leaves only roughly 65 or 70 percent of that in its natural state – now that's just the trunk. What is interesting is you move back into these tributaries we haven't mapped that yet and although I think it should be, many of those tributaries where a lot of the development is taking place today in many of those tributaries are being bulk headed at a fairly rapid rate. This gives you some idea, this is the Oriental waterfront where you have rip rap along the entire structure and with this sort of information we can look at the differences between shoreline erosion that are occurring in areas with rip rap with bulk heads; although the studies of this was in North Carolina and are limited if not non-existent. So transition from the shoreline to the shore zone and in particular when you put up these structures what you are preventing is any change in that shoreline any ecological change in that shoreline. Michael did a good introduction to the idea that what you have occurring right now in the Alligator National Wildlife Refuge is a transition from a forest environment to a marsh environment. That's what this image is trying to show that what you typically see with sea-level rise, increased flooding, (inaudible), increased salinity, forest will typically transition into a high marsh. High marsh will transition into a low marsh and low marsh is potentially flooded. That is basically the succession of an environment of sea-level risers. And as that continues if that is allowed to continue then what you have is an ecological system that can sustain itself. You continue to have marsh environments at that water's edge both high and low marsh. Then these just keep stepping back if allowed to do that and if the slope is such that can do that those will continue to step back providing that same ecological state that same ecological function with time.

One way of thinking of this is a kind of simple carpet model where what you're doing is rolling that carpet out but at the same time as you roll that carpet out, for instance the marsh rolling up that environment, you are also giving that carpet that is rolling up behind you and that is the shoreline erosion that's occurring. So what you want is for that marsh to be able to march its way up into the forest as quickly as it is eroding away on its edge. Then there is this transition zone occurring somewhere in the center. This example is just an image showing of a marsh environment freshwater marsh, moving into a forest. That transition zone of marsh to forest. In our environment what we are seeing is several different ways that this is transitioning and there are some examples – this top one is a migrating upstream. This would be an example of Broad Creek that I showed you just a minute ago or around New Bern where you have a Swamp Forest. That Swamp Forest has become saltier and saltier is going to transition into marsh and that is going to continue to move up that tributary. Migrating overland is an area where much of what is occurring and included in the Alligator Wildlife Refuge where you have marsh moving into forest

environment and this idea of a non-migrating island an example of that would be Cedar Island. Cedar Island is eroding on all of its edges and it has no place to go so that is an environment that will most certainly be lost in the future because it has no place to migrate.

Just to give you an idea of some of this migration some actual images that I can show you between two different time periods, 1958 and 1998. I am going to show you one at this N1 north 1 little slip up at Broad Creek and I'll show you some images from Cedar Island at the very opposite end of our study area. So I'll start with this is kind of a slump forest area this is the 1958 aerial image, notice there are a couple of lines drawn on there this little squiggly line is the line between marsh and forest and then this is an actual transect where samples were collected. If I toggle between this 1958 to 1998 image you can see a significant change in that shoreline, significant erosion significant loss of marsh with no transition occurring. Basically it is just a loss of land now the water is at the forest edge. We had the opportunity to actually get out there on a small plane and take some aerial images. That's at the same exact location where you can see water is now right at the forest edge. In contrast to that this is going down to Cedar Island it is actually south side of Cedar Island on (inaudible) Road. Again, you can see this transect right here - this is a forest boundary of a very small beach and then the transition that is occurring between the 1958 and 1998 image. There are several things that are occurring here if you look at the shoreline – notice that the shoreline is retreating and there is also the marsh edge along here is migrating upland. The idea of the carpet model – this is the carpet model right here perfectly shown. I mention that these systems can also accrete with time and if you look down here there are some major geo-morphological changes that are occurring. You have a significant stream here or inlet here and you don't have much of a spit over here. If you look at the difference between the two images that stream is now gone and you have a significant spit.

When I talk about accreting versus erosion this image shows all of those things occurring within just one fairly small area, why we have significant variability in these rates. That is the actual image there in the aerial photo taken recently. The idea that these systems can step back and they will transition as sea-level rises is important and that is a natural thing to occur. The problem is when there is infrastructure that might get in the way. This is a 1983 image that I was able to pull up of Point Peter Road – this is I believe a little bit further north than this point shows. I believe it is in the Alligator River National Wildlife Refuge. What is interesting is this major transition that occurs along a canal, this is marsh environment, the red is forest environment. This really demonstrates how infrastructure a road or ditch or something along that nature can stop that natural transition that provides that same function. If you allow these environments to transition on their own then you don't lose that ecological function with time. Put a ditch, put a road or something like that in the way and all of a sudden you don't allow that transition to occur. What do we do, how do we adapt? Certainly if we are thinking about adapting to climate change adapting to sea-level, what we ultimately want to do is preserve coastal North Carolina in a functional state like allowing for that same ecological function that we have today or if we can actually improve it. So in order to be able to protect our resources not at the expense of the health or function of the natural environment and in doing so there is no doubt that this idea of an economic engine. If we do this then we can continue that coastal economic engine. In general what we found is that there is no doubt that our coast is at high risk today and certainly in the future with increased changes associated with climate change.

What we've tried to do is give you a breath of example of the types of hazards that we are dealing with and specifically focusing in on estuarine shoreline erosion because I think it is not very often that we are actually thinking about that edge as opposed to the ocean's edge. You've got that hand out on this new website where we're trying to get information to the public on these different hazards NCCOHAZ (EXHIBIT P) and certainly even within that website we are trying to demonstrate the importance of shoreline erosion and not just that but the changes that are occurring along our estuarine shoreline associated with hardening. Some of the recommendations, I am not sure that adaptation works for some of these bullets that we've included but some of the recommendations – what we've done at least within the Neuse River estuary, we've documented shoreline change, we've documented a digital shoreline it provides a basis for us to evaluate change in the future. Certainly if we are going to do anything in the future to evaluate what is happening we have to have some idea of what infrastructure, what's currently at risk and the best way to adapt to it and there has got to be some initiative to go out and actually do this.

Plan carefully about placement and character of new infrastructure in the coastal zone – the idea of whether or not a road is going to be placed in a certain area that is going to prevent for instance the transition of a marsh moving into a forest. What is the ecological function that might change associated with changing the infrastructure? Determine in advance how to respond once infrastructure is removed by disaster or is the end of its engineered life. The fact that we have at least on the Outer Banks we continue to try to step our roads back and in the not too distinct future they are not going to have much room for them to step back any further - the idea that we need to start planning for whether it's worth continuing to build in these few locations that we've done in the past. Create policy (inaudible) planning preparation in action, the idea of prioritizing which coastal hazards that must be funded and an appropriate level to do so.

With what we've tried to demonstrate with our shoreline erosion site we have very little information on our shoreline. Again, for the entire 4,000 and 12,000 miles of estuarine shoreline that we've looked at is one of our estuaries the Neuse River estuary and there is very little information beyond that. Whether it's an actual digitized shoreline the wet dry line, erosion rates, how much hardening, how much of the shoreline is actual hardened or the rate at which it is being hardened, structures are being placed along it. So we need to create a baseline for the state for our estuaries, evaluate the shoreline, evaluate different habitats, evaluate structure and then ultimately from that baseline we can look at change in the future. Develop an explicit policy on the management of the estuarine shoreline. What we've shown just in the news is that the tributaries along the Neuse tend to have much lower erosion rates than what is occurring along the main trunk of the Neuse. That alone should tell us something about where we should versus what we shouldn't harden. We need to be able to keep a balance in the ecological function within our estuarine systems. We need to have the same functions whether it is wetlands, sediment bank, high sediment banks – we need to have that same function across the estuary. So in order to do that we need to look at where things can transition in the future, areas that we shouldn't harden, a hardened structure especially a vertical structure or bulk head offers no habitat. It offers no transition of that habitat in the future. Create a shoreline hardened assessment across the state to guide decision making by property owners and managers. The idea here is based

on information that, for instance, what we've done in he Neuse, we can use that information to develop an assessment of where certain structures could be placed, where hardening might not create too many problems ecologically or where we by all means should not allow any hardening or try to provide better set back.

You have several hand outs, I'll mention this is "North Carolin's Coasts in Crisis" and if it does work out J. P. Walsh and Dave Corbett will be here at your next meeting to talk a little bit about this particular publication (EXHIBIT Q) and a lot of the work that's been going on within this publication dealing with particular hazards associated with climate change. I've kind of given you a summary of the shoreline erosion as well and a publication (EXHIBIT R) that will be coming out in the near future a similar publication to this kind of a glossy pub as well as information to the North Carolina Coastal Hazards site and we encourage you to visit that to get additional information on some of these hazards and I'll stop there. I appreciate your time.

Representative Harrison: Thank you. Are there any questions from the Commission members? I appreciate you making the presentation – I am sorry we are down to such few members here. Is there any other business, any comments or questions? We'll approve the minutes at next meeting which is December 9th.

Mr. Givens: For the presenters and members who are here we do produce detailed minutes and they will become a part of the records so even if there was not a large number of people here to hear your presentation it will be preserved and become a part of the record. Note it might have some impact down the road. I call your attention to the fact that the next meeting is scheduled for Tuesday, 9 December and that we have meetings scheduled in January – Tuesday 13 January and Tuesday 27 January.

Representative Harrison: I guess that is it and we are adjourned and thank you again for sticking it out.

Meeting adjourned at 3:18 pm.

Respectfully submitted,

Representative Pricey Harrison, Co-Chair
Presiding

Thelma Utley, Commission Clerk

Mr. John Garrou, Co-Chair

APPENDICES

Exhibit A	Visitor Registration Sheet
Exhibit B	Agenda
Exhibit C	North Carolina Renewable Energy and Energy Efficiency Industry Census 2008
Exhibit D	The Center for Climate Strategies memorandum dated November 13, 2008
Exhibit E	Peer Review by David G. Tuerck, et al., of the Beacon Hill Institute analysis entitled "The Economics of Climate Change in Legislation in North Carolina"
Exhibit F	Florida Department of Environment Protection Letter
Exhibit G	Draft of Minutes for 10/23/07, 12/4/07, 1/16/08, 2/11/08, 3/5/08
Exhibit H	The Alligator River Climate Change Adaptation Pilot Project and Memo from Mike Bryant
Exhibit I	Assessing the Costs of Climate Change
Exhibit J	NC Global Warming Cornerstones
Exhibit K	The Greenhouse Gas Marketplace: Commercial Regulation of Climate Change Solutions
Exhibit L	Recommended Mitigation Options for Controlling Greenhouse Gas Emissions Final Report
Exhibit M	Recommended Mitigation Options for Controlling Greenhouse Gas Emissions Executive Summary
Exhibit N	Secondary Economic Impact Analysis of Greenhouse Gas Mitigation Options for North Carolina
Exhibit O	Interim Report to the Environmental Review Commission and the General Assembly of North Carolina
Exhibit P	NC COHAZ – ECU News Bureau
Exhibit Q	North Carolina's Coasts in Crisis: A Vision for the Future
Exhibit R	Shoreline Change in the Albemarle-Pamlico Estuarine System, North Carolina

VISITOR REGISTRATION SHEET

Legislative Commission on Global Climate Change — 11/14/2008

Name of Committee — **Date**

VISITORS: PLEASE SIGN IN BELOW AND RETURN TO COMMITTEE CLERK

NAME	FIRM OR AGENCY AND ADDRESS
David Barnes	Poyner Spruill
Jamie Fraga	NCIPL, NC Chamber of Commerce
Adam Carpenter	
John Goodman	NC Chamber
Ken Melton	Ken Melton & Assoc
Anita Watkins	NCLM
Reide Corbett	East Carolina University
J.P. Walsh	East Carolina University
Andrew Meehan	NCAEC
Wendy Kelly	S2D Wicker
Dean Plunkett	NCBIWA

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Kennie Ellis	Public Staff - Electric Division North Carolina Utilities Commission
Kathy Hawkins	Progress Energy
Lu Ann C. Bellingrath	MCIC NC
Bob Gillam	Public Staff - NCUC
Phil Morgan	Piedmont Natural Gas
David McGowan	NC Realtors Ass
Carma Hurley	Electricities
David Hales	EC of NC
Tommy Stevens	NCPC
Jon Carr	Alliance Automobile Manufacturers
Bob Ford	NCPF

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Legislative Commission on Global Climate Change

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AGENDA

10:00 a.m. Thursday 14 November 2008
Room 643 Legislative Office Building

1. Call to order
   Representative Pricey Harrison, Presiding

2. Introductory remarks by Cochairs *(5 minutes)*
   Representative Pricey Harrison
   John. L. W. Garrou

3. Report to the Commission and explanation of agenda items *(10 minutes)*
   George F. Givens, Commission Counsel

   Approval of the minutes of the 23 October 2007; 4 December 2007; 16 January 2008; 11 February, 2008; and 5 March 2008 meetings of the Commission *(2 minutes)*
   (In preparation: Minutes of the 22 April 2008 meeting)

4. Overview of various reports on climate change issued by the National Conference of State Legislators *(30 minutes)*
   Glen Andersen, Program Principal
   National Conference of State Legislators
   Environment, Energy, and Transportation Program

5. Discussion of four key action areas related to climate change (energy efficiency, clean energy, pollution capture, and long-range planning), discussed in the publication "Cornerstones," issued by the Southern Alliance for Clean Energy *(45 minutes)*
   John D. Wilson, Research Director
   Southern Alliance for Clean Energy

6. Discussion of global warming adaptation strategies to conserve fish and wildlife habitats and maintain healthy and genetically diverse wildlife populations *(20 minutes)*
   Michael R. Bryant, Project Leader
   North Carolina Coastal Plain Refuges Complex
   Alligator River National Wildlife Refuge

7. Presentation on global warming adaptation to sea-level rise in the coastal plain of North Carolina *(20 minutes)*
   Dr. Sam H. Pearsall, Ph.D.
   Southeast Regional Manager for Land, Water, and Wildlife
   Environmental Defense Fund

8. Presentation on estuarine shoreline erosion and coastal hazards in the changing climate of North Carolina *(60 minutes)*
   Dr. D. Reide Corbett, Ph.D., Associate Professor and Assistant Chair
   Dr. J.P. Walsh, Ph.D., Assistant Professor
   East Carolina University

9. Commission discussion and announcements

10. Adjourn

SCHEDULE OF FUTURE MEETINGS:

The Cochairs and Counsel have established the following schedule of meetings of the Legislative Commission on Global Climate Change for the 2008-2009 Legislative Interim. Except as noted, all meetings are scheduled for 10:00 a.m. This schedule is subject to revision.

Commission Meeting	**Location**
Tuesday 9 December 2008	643 Legislative Office Building
Tuesday 13 January 2009	1228 Legislative Building

COMMISSION WEBSITE:

In order to provide public access to the materials distributed at the meetings of the Commission and to other documents related to the Commission, a website has been developed for the Commission. The website can be viewed online at the following address:

http://www.ncleg.net/gascripts/Committees/Committees.asp?sAction=ViewCommittee&sActionDetails=Non-Standing_6268

ADDITIONAL INFORMATION:

Persons having questions about the Commission meeting or other matters related to the Commission may contact Commission Counsel or other Commission staff at (919) 733-2578.

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NAME	FIRM OR AGENCY AND ADDRESS
Thomas Moore	Edwista & Wells

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NAME	FIRM OR AGENCY AND ADDRESS
Tom Beau	EDF, SEA
David Knight	TNC
LISA RIEGEL	NHTF
Linda Pearsall	DENR
Julie Robinson	NCSEA
Van Crandall	NCSEA
Sushma Masemore	DENR/DAQ
Amy Devereaux	Citizen - Johnston Co
Jim Haven	GWI - 108 Piperwood Dr. 27518
Mark Wilder	DENR
Steve Wall	DENR

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NAME	FIRM OR AGENCY AND ADDRESS
Bill Ross	NC DENR
Shana Becker	NC Public Interest Research Group
Kris Coracini	EDF

General Assembly of North Carolina

Legislative Commission on Global Climate Change

State Legislative Building Raleigh, North Carolina

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AGENDA

10:00 a.m. Thursday 14 November 2008
Room 643 Legislative Office Building

1. Call to order
   Representative Pricey Harrison, Presiding

2. Introductory remarks by Cochairs *(5 minutes)*
   Representative Pricey Harrison
   John. L. W. Garrou

3. Report to the Commission and explanation of agenda items *(10 minutes)*
   George F. Givens, Commission Counsel

   Approval of the minutes of the 23 October 2007; 4 December 2007; 16 January 2008; 11 February, 2008; and 5 March 2008 meetings of the Commission *(2 minutes)*
   (In preparation: Minutes of the 22 April 2008 meeting)

4. Overview of various reports on climate change issued by the National Conference of State Legislators *(30 minutes)*
   Glen Andersen, Program Principal
   National Conference of State Legislators
   Environment, Energy, and Transportation Program

5. Discussion of four key action areas related to climate change (energy efficiency, clean energy, pollution capture, and long-range planning), discussed in the publication "Cornerstones," issued by the Southern Alliance for Clean Energy *(45 minutes)*
   John D. Wilson, Research Director
   Southern Alliance for Clean Energy

6. Discussion of global warming adaptation strategies to conserve fish and wildlife habitats and maintain healthy and genetically diverse wildlife populations *(20 minutes)*
   Michael R. Bryant, Project Leader
   North Carolina Coastal Plain Refuges Complex
   Alligator River National Wildlife Refuge

7. Presentation on global warming adaptation to sea-level rise in the coastal plain of North Carolina *(20 minutes)*
   Dr. Sam H. Pearsall, Ph.D.
   Southeast Regional Manager for Land, Water, and Wildlife
   Environmental Defense Fund

8. Presentation on estuarine shoreline erosion and coastal hazards in the changing climate of North Carolina *(60 minutes)*
   Dr. D. Reide Corbett, Ph.D., Associate Professor and Assistant Chair
   Dr. J.P. Walsh, Ph.D., Assistant Professor
   East Carolina University

9. Commission discussion and announcements

10. Adjourn

SCHEDULE OF FUTURE MEETINGS:

The Cochairs and Counsel have established the following schedule of meetings of the Legislative Commission on Global Climate Change for the 2008-2009 Legislative Interim. Except as noted, all meetings are scheduled for 10:00 a.m. This schedule is subject to revision.

Commission Meeting	**Location**
Tuesday 9 December 2008	643 Legislative Office Building
Tuesday 13 January 2009	1228 Legislative Building

COMMISSION WEBSITE:

In order to provide public access to the materials distributed at the meetings of the Commission and to other documents related to the Commission, a website has been developed for the Commission. The website can be viewed online at the following address:

http://www.ncleg.net/gascripts/Committees/Committees.asp?sAction=ViewCommittee&sActionDetails=Non-Standing_6268

ADDITIONAL INFORMATION:

Persons having questions about the Commission meeting or other matters related to the Commission may contact Commission Counsel or other Commission staff at (919) 733-2578.

Michael Reagan
Dan Crawford CENC

House Pages

JLC Global Climate Change

Name Of Committee: ~~DROPOUT~~ Date: 11-13-08

Sgt at Arms

1. Name: John Brandon
   County: Dusty Rhodes
   Sponsor: David Shearon
2. Name: Charles Williams
   County:
   Sponsor:

House Sgt at Arms

3. Name: Charles Marsalis
   County: Ernie Sherrell
   Sponsor: Ron Spann

Senate Sgt at Arms

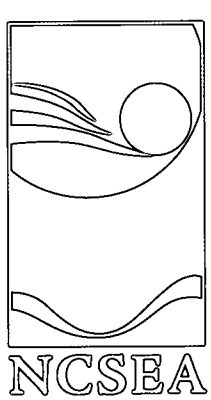
4. Name:
   County:
   Sponsor:
5. Name:
   County:
   Sponsor:

Sgt-At-Arms

1. Name: ~~MARVIN LEE~~ JON Fitch
2. Name: ~~JOHN BRANDON~~ Curtis
3. Name: ~~JAMES WORTH~~ Stan
4. Name:
5. Name:

Senate
David
Johnson

North Carolina Renewable Energy and Energy Efficiency Industry Census 2008



Produced by the North Carolina Sustainable Energy Association

October 2008



North Carolina Sustainable Energy Association

Mission:

To ensure a sustainable future by promoting renewable energy and energy efficiency in North Carolina through public policy, education, and economic development.

Project Director: Paul Quinlan
Project Lead: Abbie Turiansky

P.O. Box 6465
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This publication is made possible through the support of the Foundation for the Carolinas, the Z. Smith Reynolds Foundation and NCSEA Membership Dues.

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INTRODUCTION

What are green jobs?

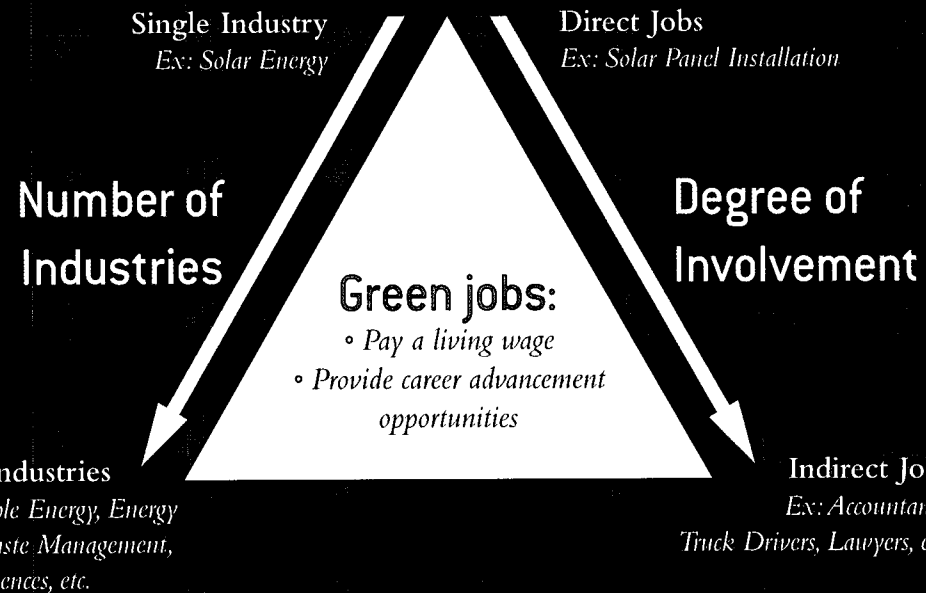
The term "green jobs" has become ubiquitous — appearing in numerous reports, human interest news stories, and political speeches. However, the term leaves many wondering: what exactly is a green job?

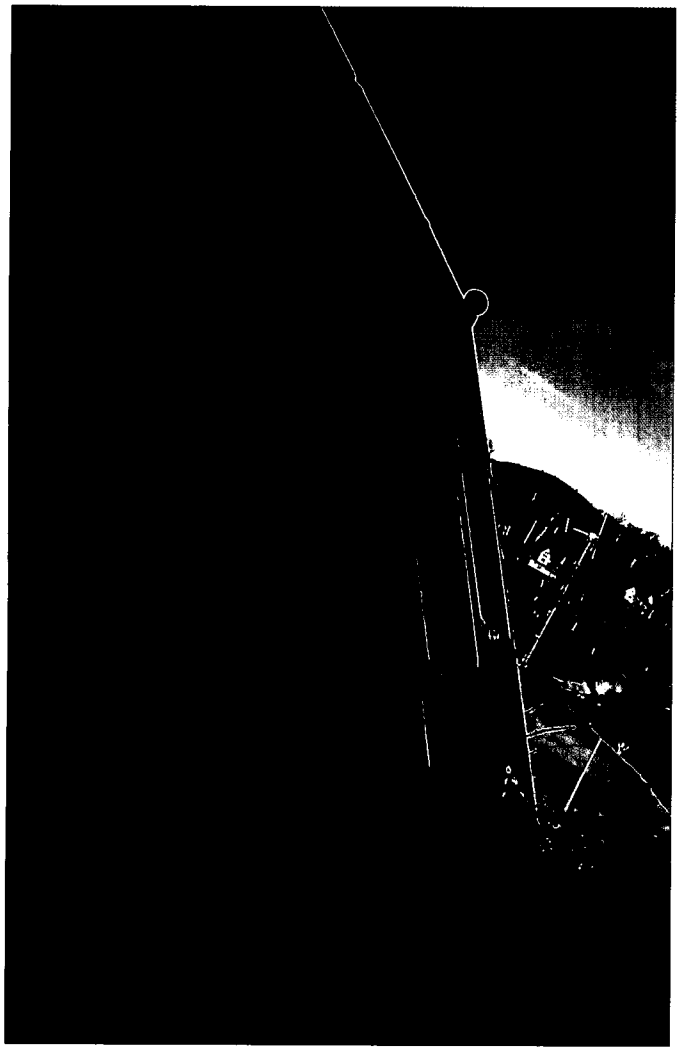
The answer to this question is highly contextual and depends on the scope of two important underlying criteria. The first criterion is the number of industries being considered. The term could apply to a single industry — such as solar energy — or all industries that have a net positive impact on the environment. The broader definition could encompass numerous industries ranging from renewable energy to waste management to biological science professions.

The second important criterion related to green jobs is the employee's degree of involvement in the defined industry. Each industry will consist of direct and indirect jobs, which will vary depending on how these jobs are defined. For example, one analysis of the solar energy industry may consider manufacturing jobs as a direct job because they occur within the industry's supply chain. Meanwhile, a second analysis may focus on the jobs associated with solar installation and classify manufacturing jobs to be indirect jobs because they are removed from the installation of the final product.

The importance of these underlying criteria can be seen in Figure 1, which shows the two criteria along a spectrum. The top of the pyramid illustrates a narrow definition of "green jobs" as it accounts for direct jobs in a single industry. A move down one or both of the spectrums results in a greater number of jobs becoming classified as "green jobs". A definition encompassing the entire pyramid would include both direct and indirect jobs in all industries that have a net positive impact on the environment.

Figure 1. *Understanding 'Green Jobs.'*





WHAT IS THE PURPOSE OF THIS REPORT?

The North Carolina Sustainable Energy Association (NCSEA) is interested in the direct and indirect jobs in North Carolina associated with the renewable energy and energy efficiency industries. While the industry has significant potential to create jobs in North Carolina, very little is known about this industry. Common questions about the industry include:

- How many firms are working in the renewable energy and energy efficiency industries?
- How many people are employed by these firms?
- How fast are these firms growing and what types of jobs will be available in the future?

To begin to answer these questions, NCSEA conducted a Renewable Energy and Energy Efficiency Industry Census. The purpose of the Census was to quantify the number of firms and jobs in this rapidly growing industry. NCSEA intends to make this an annual survey in order to track the expansion of this fast-growing industry.

As part of the Census, NCSEA identified and surveyed 486 firms which comprise the renewable energy and energy efficiency supply chain in North Carolina. Each firm was asked to identify the percentage of staff time dedicated to industry-related work. The firms were largely businesses, but included a few state agencies and nonprofit organizations. A total of 166 firms responded to the survey and met at least one of the following criteria:[1]

- At least 50% of staff time is dedicated to work related to the renewable energy and energy efficiency industry.
- At least 50% of revenue comes from work related to the renewable energy and energy efficiency industry.
- Companies generate at least $25,000 in revenue from work related to the renewable energy and energy efficiency industry.

Based on the information provided by responding firms, NCSEA believes this line of questioning provides a reasonable measure of direct and indirect jobs.

This document presents key findings from the industry census. Throughout the report, findings will indicate the number of respondents to the corresponding survey question. For example, "n=166" would mean 166 firms answered a particular question. The figures are often less than the total number of responding firms (n=166) because some firms did not reply or opted out of some questions.

It should also be noted that all data is self-reported by participating firms. And, key findings are presented in the aggregate to protect the confidentiality of participating firms.

EMPLOYMENT TRENDS

Responding firms report 2,144 full-time equivalent jobs dedicated to renewable energy and energy efficiency in North Carolina.

Employment in the renewable energy and energy efficiency industry includes a diverse range of positions related to research and development; manufacturing; distribution and sales; installation of renewable energy technologies; implementation of energy efficiency measures; operation and maintenance; and government

Table 1. *Total Number of Jobs Reported by Firms (n=161), 2008.*

Type of Firm	Manufacturing		Non-Manufacturing		Totals	
	Number of Firms	Number of Jobs	Number of Firms	Number of Jobs	Number of Firms	Number of Jobs
Renewable Energy	8	77	20	70	**28**	**147**
Energy Efficiency and/or Demanad Response	10	136	56	193	**66**	**329**
Renewable Energy & Energy Efficiency	11	1,310	56	358	**67**	**1,668**
Total	29	1,523	132	621	161	2,144

and support services. Firms reporting employment data (n=161) provide 2,144 full-time equivalent jobs in North Carolina's renewable energy and energy efficiency industry.[2] Throughout the remainder of this report, the term "job" or "employee" will be used to refer to a full-time equivalent job or employee.

Over 70% of the jobs occur in firms involved with manufacturing.

Manufacturing, which has long been important to North Carolina's economy, has seen sharp declines in recent years. However, manufacturing forms an important component of the renewable energy and energy efficiency industry in North Carolina. While a limited number of the firms reporting employment information are involved in manufacturing, these companies tend to be larger than average, and contribute more than 70% of the reported jobs (see **Table 1**).[3]

In 2007, global investment in sustainable energy surpassed $148 billion — a 60% increase from 2006.[4] Manufacturing firms interact with this growing global industry, but firms focused on installation are much more dependent on trends in local and regional markets. This difference accounts for the dominance of jobs at firms involved with manufacturing relative to jobs at firms not involved with manufacturing. Most of the manufacturing firms in North Carolina produce components, rather than end units, for the renewable energy and energy efficiency industry.[5] These firms will continue to benefit from the strong global demand for renewable energy and energy efficiency solutions.

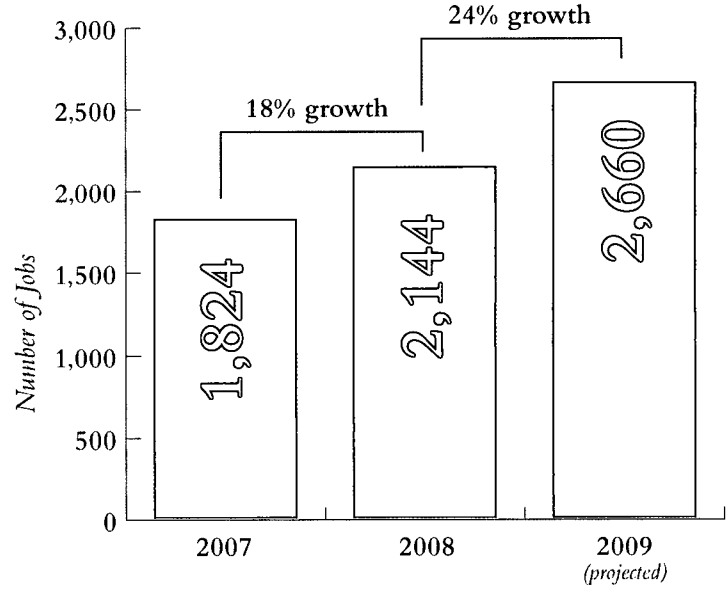


Figure 2. *Total Number of Renewable Energy and Energy Efficiency Jobs Reported by Firms (n=161).*

The census results also indicate that firms specializing solely in renewable energy represent the smallest segment of the renewable energy and energy efficiency industry in North Carolina (see **Table 1**). They only account for 17% of the firms reporting employment information and a mere 7% of the reported employees. However, significant growth is expected from these firms with the implementation of the North Carolina Renewable Energy and Energy Efficiency Portfolio Standard, which requires public electric utilities to generate at least 12.5% of their electricity from renewable energy resources and energy efficiency measures by the year 2021.[6]

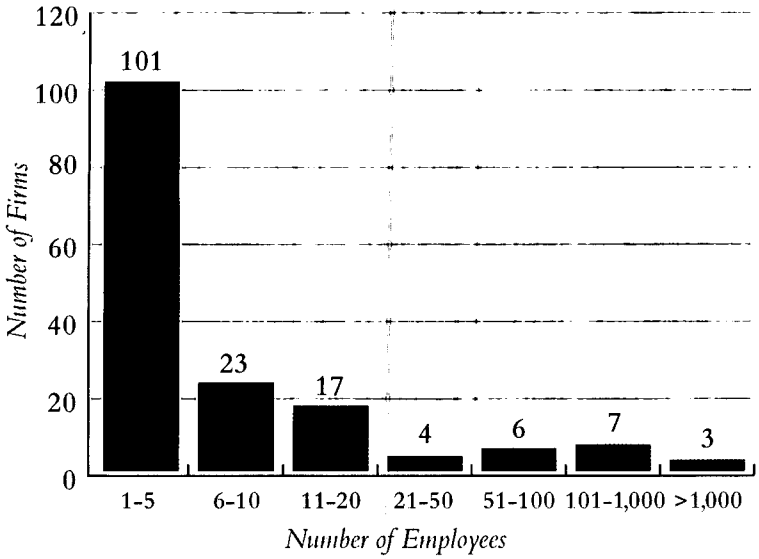


Figure 3. *Number of firms in the renewable energy and energy efficiency industry (n=161).*

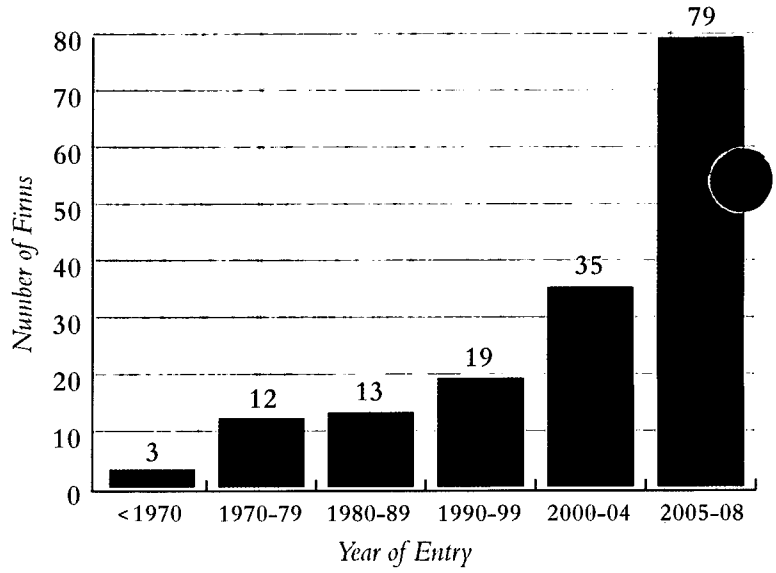


Figure 4. *Year of entry into renewable energy and energy efficiency industry (n=161).*

Steady employment growth is expected.

Firms in the renewable energy and energy efficiency industry report significant employment growth over the last 12 months and expect even greater growth in the next year. The firms reporting employment data added 320 employees in the last 12 months — an 18% increase (see **Figure 2**). The same firms expect to add another 516 employees in the next 12 months — a 24% increase.

Small firms will be the primary source of employment growth in the sector. Almost 80% of total projected employment growth is reported by firms that employ 100 people or fewer. The smallest firms — those that employ 5 people or fewer — account for nearly one-third of the total projected employment growth.

This rapid growth can be attributed to global demand for sustainable energy and state-level policy reforms that have begun to remove regulatory barriers in North Carolina. As noted earlier, firms involved in manufacturing can contribute to the global economy. Meanwhile, state-level policies are particularly important to smaller firms, who are more focused on delivering products and services to local and regional markets. With continued global demand and state-level support, North Carolina has the potential to grow this industry well into the future.

Accounting for all identified firms, the industry could consist of over 6,470 jobs.

The full size of the industry can be estimated by applying the average number of employees reported to all of the 486 firms identified for the census. The calculation reveals that the renewable energy and energy efficiency industry could provide 6,470 jobs to the North Carolina economy. While informative, this figure should be considered rudimentary. Due to a lack of information from non-responding firms, NCSEA was unable to weigh results by type of company or determine whether the average number employees in responding firms was representative of the broader industry. Nevertheless, the figure suggests a significant — and yet overlooked — renewable energy and energy efficiency industry already exists in the state.

INDUSTRY DYNAMICS

Most firms are small and new to the industry.

Most firms in the renewable energy and energy efficiency industry are small and relatively new to the industry. More than three quarters of the firms that provided

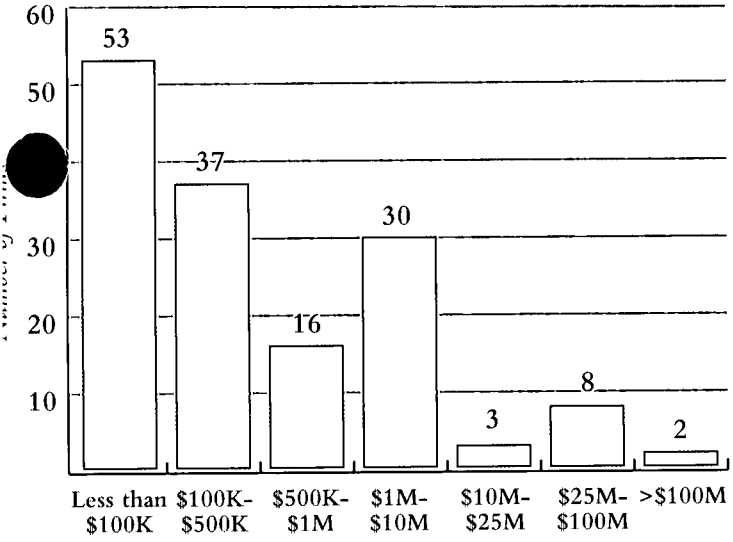


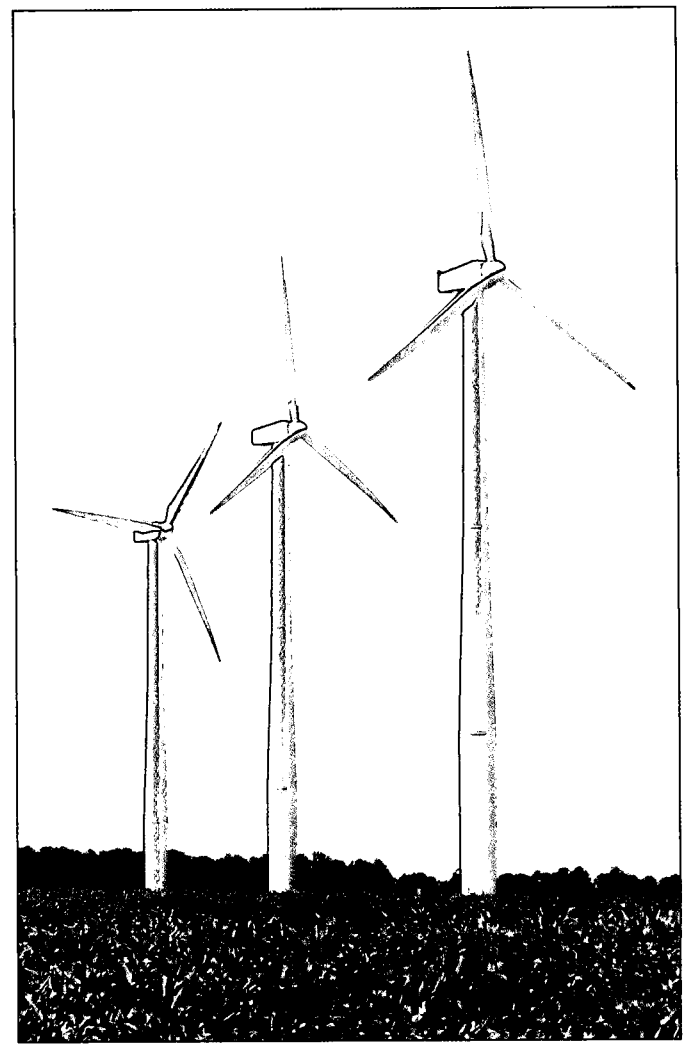
Figure 5. *Total annual revenue in most recent fiscal year (n=149).*

employment data consist of ten or fewer people (see **Figure 3**); and nearly a quarter of the responding firms employ one person. The size of the industry has grown modestly since the 1970s, with an explosion of new firms entering the industry in the last few years (see **Figure 4**). In fact, more than half of the responding firms (n=161) began working in the renewable energy and energy efficiency industry since 2000. Among these younger firms, roughly two-thirds of the organizations began operations as renewable and/or energy efficiency firms while one-third of the firms transitioned or diversified into the industry from other activities or markets.

The smallest firms were more likely to be new to the industry. Seventy-two percent of the firms with ten or fewer people entered the industry since 2000, compared to 60% among larger firms. These smaller firms also have fewer resources and dedicate more staff time to industry related activities.

The prominence of small, new firms is also evident in reported revenue. Two-thirds of responding firms (n=149) reported total annual revenues of less than $1 million (see **Figure 5**).

While small firms are dominant, the importance of large firms should not be overlooked as they supply the bulk of the reported employment. For instance, the ten largest firms account for over half of the reported employment. In addition, the majority of these firms dedicate just a portion of their staff resources to industry related activities.



Most firms report that employees arrive with required skills, but these skills are expected to change significantly over the next 2-5 years.

The industry census collected information pertaining to the skills required by employees in the renewable energy and energy efficiency industry. In one question, firms were asked how strongly they agree with the statement, "My employees arrive with the skills they need to do the jobs for which they are hired." Most of the responding firms (n=155) reported their employees arrive with the required skills (see **Table 2**). However, it is notable that 40% of the responding firms — most of whom were smaller firms — disagreed or strongly disagreed with the statement. This point is important because it indicates that small firms — who will account

Table 2. *Findings Related to Employee Skills.*

	Number of Responses				
	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
My employees arrive with the skills they need to do the jobs for which they are hired.	26	49	18	53	9
I expect the skills required for my specific industry to change significantly over the next 2-5 years.	41	57	10	45	3

for the majority of the employment growth in the next year — are having difficulty finding skilled employees.

The second skills question asked firms how strongly they agree with the statement, "I expect the skills required for my industry to change significantly over the next 2-5 years." Nearly two-thirds of the responding firms (n=150) indicated they believe their employees will need to acquire new skills in the coming years (see **Table 2**). More importantly, the firms that believe the required skills will change over time employ 77% of the reported employees.

In sum, most firms are finding skilled workers, but smaller firms — who project the greatest growth in employment — have the most difficulty finding employees with the required skills. Further, the required skills for most employees in the renewable energy and energy efficiency industry are likely to significantly change in the next 2-5 years. These findings suggest workforce development will be an important issue for the growth and success of the industry.

Renewable energy and energy efficiency firms maintain a presence across the state; headquarters are predominantly clustered in the west and Research Triangle regions.

The industry census sought to understand the geographic distribution of renewable and energy efficiency firms in North Carolina. Each firm was asked to identify counties where they maintain an employee base — this could represent a satellite office, a manufacturing facility, or one or more employees working remotely. It can be seen in **Figure 6** that the industry has a wide presence across the state. The responding firms (n=163) report a presence in 64 of North Carolina's 100 counties. Regional hubs can be seen in Buncombe, Mecklenburg and Wake Counties — over 50 firms maintain a presence in each of these counties, which are highlighted in red in **Figure 6**.

The distribution of firms can also be viewed by the seven public-private regional development partnerships: [7]

- AdvantageWest Economic Development Group
- Charlotte Regional Partnership
- North Carolina's Eastern Region
- North Carolina's Southeast
- Northeastern North Carolina Regional Economic Development Commission
- Piedmont Triad Partnership
- Research Triangle Regional Partnership

The primary locations — or headquarters — of most firms are located in counties associated with the AdvantageWest Economic Development Group and the Triangle Regional Partnership (see **Table 3**). The Charlotte Regional places a distant third, suggesting several firms have a presence in the region, but have located their headquarters elsewhere in the state.

It is important to note that the geographic distributions reported above do not reflect the number of reported employees per county or region. With manufacturing firms being some of the largest employers, many industry jobs can be found in rural counties across the state. County level employment is not reported because the census questions did not allow for the accurate county allocation of reported jobs.

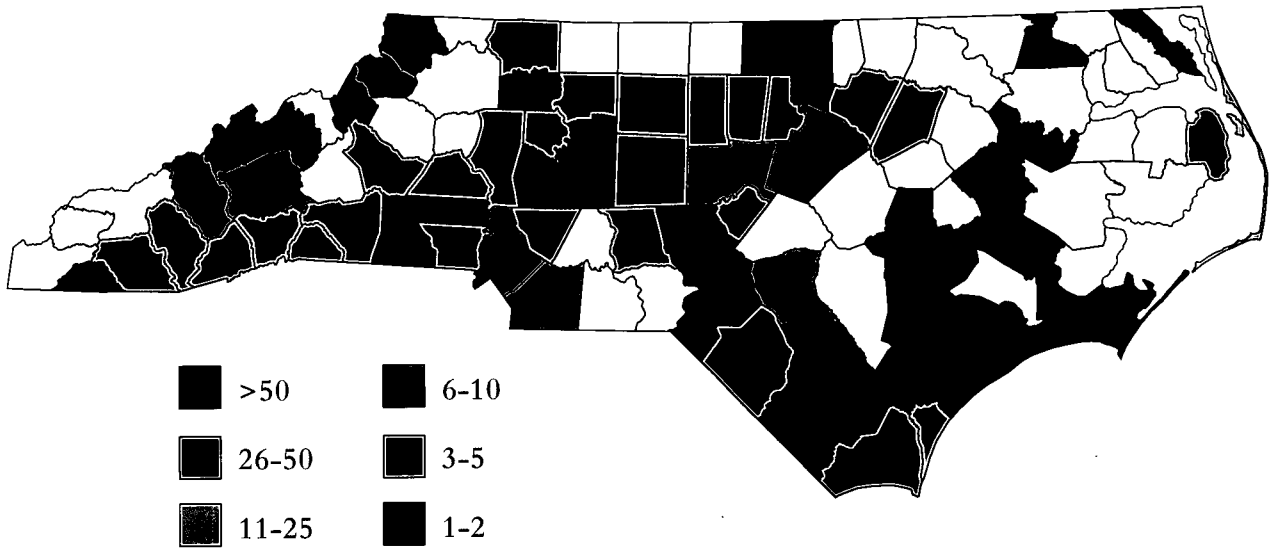


Figure 6. *Presence of responding firms by county.*

Conclusion

North Carolina maintains a young, robust and growing renewable energy and energy efficiency industry. Stimulated by global demand for sustainable energy products, NCSEA found the majority of reported jobs are associated with firms involved in manufacturing. Numerous firms manufacture critical components rather than finished products – for the industry.

The enactment of state policies – such as the NC Renewable Energy and Energy Efficiency Portfolio Standard – has increased local demand and spurred growth among firms providing installation services. NCSEA expects the majority of new industry employment will occur among these service providers, as well as manufacturing firms that establish business or retool their facilities in North Carolina.

In both cases, a major challenge facing this emerging industry will be access to a skilled workforce. Small firms already report difficulty finding employees with required skills, which are expected to change significantly over the next few years. Nevertheless, a concerted effort to overcome this, and several other regulatory barriers, would position North Carolina as a national and regional leader in the new energy economy.

Table 3. *Location of headquarters by region (n=163).*

Economic Partnership Regions	# of Firms
Advantage West	50
Charlotte	32
Eastern Region	2
Northeast	2
Piedmont Triad	17
Research Triangle	50
Southeast	10

1 *A full description of census definitions can be found in Appendix 1. A description of the census methodology can be found in Appendix 2. A copy of the census questions can be found in Appendix 3.*

2 *A full-time equivalent is a measure equal to the work of one full-time employee. The work of two half-time employees would be equal to one full time equivalent. The total number of full-time equivalents for a firm was calculated by multiplying the total number of employees by the percent of staff time dedicated to activities related to renewable energy and energy efficiency.*

3 *Respondents were able to identify more than one activity; some manufacturing firms are also involved in other activities, such as research and development, distribution, or installation.*

4 *United Nations Environment Programme and New Energy Finance. Global Trends in Sustainable Investment 2008. <http://sefi.unep.org/english/globaltrends.html> [Accessed: 3 August 2008].*

5 *Appalachian State University Energy Center. North Carolina Economic Developer's Guide to the Renewable Energy Industries. Volume 2. Winter 2008. <http://www.energy.appstate.edu/docs/devguide_v2.pdf> [Accessed: 3 August 2008].*

6 *For additional information about the Portfolio Standard, see the NCSEA publication: A Citizen's Guide: The North Carolina Renewable Energy and Energy Efficiency Portfolio Standard.*

7 *A listing of counties associated with each of these partnerships can be found in Appendix 4.*

Appendix 1: Census Definitions

Firms were included in the North Carolina Renewable Energy and Energy Efficiency Census if they met at least one of the following criteria:

1. At least 50% of staff time is dedicated to work related to renewable energy or energy efficiency.
2. At least 50% of revenue comes from work related to renewable energy or energy efficiency.
3. Firm generate at least $25,000 in revenue from work related to renewable energy or energy efficiency.

These criteria allowed NCSEA to include firms specializing in renewable energy or energy efficiency as well more diversified firms that are significant to the industry. For the purpose of the census, renewable energy and energy efficiency firms and activities were defined as:

Renewable Energy: Firms that develop, design, engineer, finance, manufacture, install, or maintain renewable energy systems and components.

Renewable energy industry activities include:

- Manufacturing of renewable energy components or assembly of finished products.
- Design, installation, and construction of renewable energy systems. This may also include related items, such as site selection and environmental impact assessments.
- Operations and maintenance of renewable energy systems.
- Growing, harvesting, or transporting renewable fuel crops intended for electric generation.

Energy Efficiency: Firms that develop, manufacture, or install systems that cut energy waste, such as energy-efficient homes and buildings, LED lighting, building controls, and efficient appliances.

Energy efficiency industry activities include:

- Manufacturing of construction materials and devices designed to make buildings more efficient, such as compact fluorescent light bulbs, motion sensors, thermostats, efficient windows and window treatments, and efficient appliances.
- Distribution and installation of efficiency systems, weatherization, providing energy audits, HVAC, engineering, or electrical services.
- Green Building: design and construction of energy efficient homes and buildings — defined as homes that are certifiable by Energy Star, LEED, NC Healthy Homes, or comparable third-party verification system.

Appendix 2: Census Methodology

1. **Develop a definition for a renewable energy and energy efficiency firm.** The definition was based on definitions used in previous studies and the relevant industries that are present in North Carolina.

2. **Build database of targeted respondents.** A database of firms was developed from the following listings. The resources were used to identify firms, and NCSEA followed the contact protocol established by each listing organization.

- NCSEA Business Members Database
- American Wind Energy Association Member Directory
- Appalachian State University Energy Center Manufacturers List
- EPA Energy Star Business Partners
- FindSolar.com Online Directory
- Green Home Builders of the Triangle Member Directory
- NC HealthyBuilt Homes Member Directory
- North Carolina Solar Center Directory of Renewable Energy Professionals
- Residential Energy Services Network (RESNET) Certified Raters Directory
- Small Business Innovation Research Recipients List
- Source Guide Renewable Energy Businesses
- US Green Building Council Member Directory
- Western North Carolina Green Building Council Business Members List

NCSEA also relied on contacts known to the authors and colleagues. In some cases, contact information was acquired through online research or phone calls.

3. **Create, pre-test, and revise census survey.** Survey questions were developed and tested on a variety of partner firms and colleagues in order to improve the clarity of the questions and overall flow of the survey. The survey was revised repeatedly throughout the pre-testing process in response to feedback from test respondents.

4. **Invite firms to participate in the online survey.** Survey questions were entered into an online survey tool, and participants received a cover letter with a link to the online survey in July 2008. In order to increase the survey response rate, those respondents that did not respond to the survey after additional email reminders were called and encouraged to complete the survey.

5. **Identify additional respondents.** All participants were asked to list up to three companies or organizations they work with so that these firms could be added to the survey if they were appropriate to be included. These additional contacts were then sent the cover letter and link to the online survey.

6. **Review responses and clean dataset.** Survey results were reviewed for completeness and accuracy, and follow-up phone calls were made to correct or verify information if necessary.

Appendix 3: Survey Questions

1. What is your entity's name and website?

Entity refers to the company, association, agency, or organization.

Name:_____

Website: _____

2. What is your contact information?

First Name:_____

Job Title:_____

Telephone Number:_____

Email Address: _____

3. Where is your primary North Carolina location?

Primary location refers to the NC headquarters, if applicable, or the facility location with the NC-based management team.

Mailing Address:_____

City:_____

County:_____

Zip Code: _____

4. Is your headquarters located in North Carolina?

a. Yes b. No

5. Do you have more than one location in North Carolina? Please include locations where you have employees based.

a. Yes b. No

If "yes" to question 5:

6. In which counties does your entity have locations? Check all that apply.

List of North Carolina counties appeared.

_____

7. What year did your entity begin operating in North Carolina?

_____

8. What year did your entity begin to work in the renewable energy or energy efficiency sector or begin to use renewable energy or energy efficiency technology in your work?

_____

9. In which industry does your entity primarily work?

If you do not work directly in one of these industries, please select the industry that your work supports.

a. Renewable energy (e.g. production, installation, or manufacturing of renewable system components)

b. Energy efficiency and/or demand response (e.g. manufacturing or installation of efficiency systems and products, or energy-efficient construction and green building)

c. Both renewable energy and energy efficiency

If answered "c" to question 9:

10. Which industry segment is your primary focus?

a. Biomass

b. Fuel Cells and Hydrogen

c. Geothermal

d. Hydro Power

e. Solar (electric, thermal, or passive)

f. Wind

g. Other

11. Which best describes your entity?

a. Government Agency

b. Business

c. Non-Profit

d. Public Utility

e. Other:

12. Which of the following activities best apply to your company or organization? Check all that apply.

a. Product Research and Development

b. Manufacturing

c. Distribution and sales

d. Installation of renewable energy systems

e. Installation of energy efficiency systems

f. Engineering

g. Architecture/design

h. Construction

i. Home building and/or remodeling

j. Energy rater

k. Energy service company (ESCO)

l. Software and IT

m. Renewable energy facility owner/operator

n. Electrical Service Provider

o. Research/education

p. Contracting

q. Financial Services

r. Law

s. Public Relations

t. Other:_____

13. What is your entity's current total North Carolina employment?

Please estimate based on full-time equivalent staff time (for example, two employees working half-time equal one full-time equivalent).

_____

14. What percent (%) of your North Carolina staff time is dedicated to work within the renewable energy or energy efficiency sectors?

For example, if you work in building/construction, what percent of staff time is spent on homes/buildings certified by NAHB's green program, LEED, or a comparable system? Please estimate based on full-time equivalent staff time.

_____

15. How many new North Carolina full-time equivalent staff members dedicated to renewable energy or energy efficiency have you hired in the past 12 months?

_____

16. How many new North Carolina full-time equivalent staff members dedicated to renewable energy or energy efficiency do you anticipate hiring in the next 12 months?

_____

17. What was your total North Carolina annual revenue in the most recently concluded fiscal year?

Please estimate if you do not know the exact number.

a. Less than $100,000

b. $100,000 but less than $500,000

c. $500,000 but less than $1 million

d. $1 million but less than $10 million

e. $10 million but less than $25 million

f. $25 million but less than $100 million

g. $100 million or more

h. Refuse to answer/Do not know

18. What percent of your firm's annual revenue was attributable to the renewable energy or energy efficiency industry in the most recently concluded fiscal year?

For example, if you are a manufacturer, what percent of your revenue comes from products used in renewable energy systems or Energy Star products?

a. less than 10%

b. 10% but less than 25%

c. 25% but less than 50%

d. 50% but less than 75%

e. 75% but less than 100%

f. 100%

g. Refuse to answer/Do not know

19. How strongly do you agree with the following statements

a. My employees arrive with the skills they need to do the jobs for which they are hired.

i. Strongly Agree

ii. Somewhat Agree

iii. Somewhat Disagree

iv. Strongly Disagree

v. No Opinion

b. I expect the skills required for my specific industry to change significantly over the next 2-5 years.

i. Strongly Agree

ii. Somewhat Agree

iii. Somewhat Disagree

iv. Strongly Disagree

v. No Opinion

If so, how do you expect these required skills to change?

_____

20. What are your CEO/Managing Director's top three concerns that might inhibit profit growth in the renewable energy and energy efficiency industry in 2008?

1._____

2._____

3._____

21. If applicable, which states do you believe are most supportive of growing a renewable energy and energy efficiency industry, and why?

1._____

2._____

3._____

22. We would like to ensure that our census captures as many relevant North Carolina companies and organizations as possible. We would appreciate if you would provide us with the names of three companies, associations, or organizations that you work with so we can include them in our study.

1._____

2._____

3._____

23. Would you like to be notified when a summary report of this survey is completed and receive future communication from NCSEA?

a. Yes, please notify me when a summary report is posted and NCSEA may contact me about other initiatives and news.

b. Please notify me when a summary report is posted but I would prefer not to receive further communications from NCSEA

c. No, thank you.

24. Please provide additional comments, concerns, or thoughts about the renewable energy and energy efficiency industry that were not covered by this survey.

_____

Appendix 4: County Designations

County	Partnership Region	Geographic Region	County	Partnership Region	Geographic Region
Alamance	Piedmont Triad	Piedmont	Johnston	Research Triangle	Piedmont
Alexander	Charlotte	Piedmont	Jones	Eastern Region	Coast
Alleghany	Advantage West	Mountain	Lee	Research Triangle	Piedmont
Anson	Charlotte	Piedmont	Lenoir	Eastern Region	Coast
Ashe	Advantage West	Mountain	Lincoln	Charlotte	Piedmont
Avery	Advantage West	Mountain	Macon	Advantage West	Mountain
Beaufort	Northeast	Coast	Madison	Advantage West	Mountain
Bertie	Northeast	Coast	Martin	Northeast	Coast
Bladen	Southeast	Coast	McDowell	Advantage West	Mountain
Brunswick	Southeast	Coast	Mecklenburg	Charlotte	Piedmont
Buncombe	Advantage West	Mountain	Mitchell	Advantage West	Mountain
Burke	Advantage West	Mountain	Montgomery	Piedmont Triad	Piedmont
Cabarrus	Charlotte	Piedmont	Moore	Research Triangle	Piedmont
Caldwell	Advantage West	Mountain	Nash	Eastern Region	Coast
Camden	Northeast	Coast	New Hanover	Southeast	Coast
Carteret	Eastern Region	Coast	Northampton	Northeast	Coast
Caswell	Piedmont Triad	Piedmont	Onslow	Eastern Region	Coast
Catawba	Charlotte	Piedmont	Orange	Research Triangle	Piedmont
Chatham	Research Triangle	Piedmont	Pamlico	Eastern Region	Coast
Cherokee	Advantage West	Mountain	Pasquotank	Northeast	Coast
Chowan	Northeast	Coast	Pender	Southeast	Coast
Clay	Advantage West	Mountain	Perquimans	Northeast	Coast
Cleveland	Charlotte	Piedmont	Person	Research Triangle	Piedmont
Columbus	Southeast	Coast	Pitt	Eastern Region	Coast
Craven	Eastern Region	Coast	Polk	Advantage West	Mountain
Cumberland	Southeast	Coast	Randolph	Piedmont Triad	Piedmont
Currituck	Northeast	Coast	Richmond	Southeast	Coast
Dare	Northeast	Coast	Robeson	Southeast	Coast
Davidson	Piedmont Triad	Piedmont	Rockingham	Piedmont Triad	Piedmont
Davie	Piedmont Triad	Piedmont	Rowan	Charlotte	Piedmont
Duplin	Eastern Region	Coast	Rutherford	Advantage West	Mountain
Durham	Research Triangle	Piedmont	Sampson	Southeast	Coast
Edgecombe	Eastern Region	Coast	Scotland	Southeast	Coast
Forsyth	Piedmont Triad	Piedmont	Stanly	Charlotte	Piedmont
Franklin	Research Triangle	Piedmont	Stokes	Piedmont Triad	Piedmont
Gaston	Charlotte	Piedmont	Surry	Piedmont Triad	Piedmont
Gates	Northeast	Coast	Swain	Advantage West	Mountain
Graham	Advantage West	Mountain	Transylvania	Advantage West	Mountain
Granville	Research Triangle	Piedmont	Tyrrell	Northeast	Coast
Greene	Eastern Region	Coast	Union	Charlotte	Piedmont
Guilford	Piedmont Triad	Piedmont	Vance	Research Triangle	Piedmont
Halifax	Northeast	Coast	Wake	Research Triangle	Piedmont
Harnett	Research Triangle	Piedmont	Warren	Research Triangle	Piedmont
Haywood	Advantage West	Mountain	Washington	Northeast	Coast
Henderson	Advantage West	Mountain	Watauga	Advantage West	Mountain
Hertford	Northeast	Coast	Wayne	Eastern Region	Coast
Hoke	Southeast	Coast	Wilkes	Advantage West	Mountain
Hyde	Northeast	Coast	Wilson	Eastern Region	Coast
Iredell	Charlotte	Piedmont	Yadkin	Piedmont Triad	Piedmont
Jackson	Advantage West	Mountain	Yancey	Advantage West	Mountain

Source: *NC State of the Workforce, NC Department of Commerce, January 2007.*

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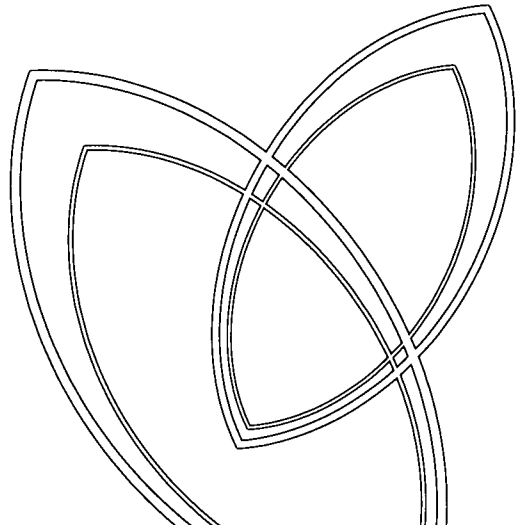
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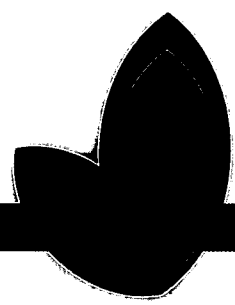
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For more information on the renewable energy and energy efficiency industry and its jobs, as well as other recent studies, go to: **www.energync.org.**



Wood saved: **244** lbs
Water saved: **457** gals
Landfill reduced: **52** lbs
Net greenhouse emissions: **126** lbs
Energy reduced: **840,564** BTUs

(Calculations based on research by Environmental Defense and other members of the Paper Task Force.)





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The Center for Climate Strategies

Helping States and the Nation Tackle Climate Change

www.climatestrategies.us

To: The North Carolina Legislative Commission on Global Climate Change

Cc: George Givens, Supervisor, Environmental Team Research Division

Brock Nicholson, Department of Air Quality, North Carolina Department of Environment and Natural Resources

From: Tom Peterson and Randy Strait, Center for Climate Strategies

Re: Completion of the North Carolina Climate Action Plan Advisory Group Report and Supplemental Macroeconomic Analysis

Date: November 13, 2008

Since the last meeting of the North Carolina Legislative Commission on Global Climate Change (LCGCC), the Center for Climate Strategies (CCS) and the North Carolina Department of Environment and Natural Resources (DENR) have completed and posted the final report and recommendations of the 46 members of the North Carolina Climate Action Plan Advisory Group (CAPAG). It is available at www.ncclimatechange.us.

The report details 56 comprehensive, climate mitigation action recommendations in all state economic sectors estimated by the CAPAG to reduce greenhouse gas (GHG) emissions in North Carolina to 1990 levels by 2020 and yield a net savings of over $5 billion. According to a supplemental macroeconomic analysis by Appalachian State University (ASU), these actions are estimated to create more than 15,000 jobs, $565 million in employee and proprietor income, $302 million in gross state product, $2.2 billion in net additional employee and proprietor income, and more than $1.2 million in net gross state product by 2020.[1]

Several of the early CAPAG recommendations were previously approved by the LCGCC for legislative consideration. As the LCGCC considers the remaining CAPAG recommendations for legislative action, the CAPAG report and "Secondary Economic Impact Analysis of Greenhouse Gas Mitigation Options for North Carolina" by ASU provide highly detailed policy descriptions and economic analysis.

At an earlier meeting of the LCGCC, during the draft analysis of the ASU report, a

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[1] This study was done at the request of CCS and DENR, and included a peer review from members of several universities to support development of the ASU model; responses to their comments are incorporated in the ASU report.

critique of this draft analysis was provided by the Beacon Hill Institute (BHI) under contract by the John Locke Foundation. In response to questions, CCS requested peer review of the BHI critique. Comments by reviewers are attached and include number of technical concerns about the BHI document and its applicability to the CAPAG and ASU results. For additional background, we are also attaching a recent response by Secretary Michael Sole of the Florida Department of Environmental Protection to a BHI issued critique of the Florida Climate Action Plan provided by the James Madison Institute.

Since the LCGCC last met, a number of new developments on climate change policy actions have occurred. To date 23 U.S. states have completed comprehensive climate mitigation action plans (including five Southern states in Table 1 below), and seven others are underway. Figures 1 and 2 below show compiled results of quantified policy recommendations from 20 states in the form of a cost curve and "wedge" graph of sector based greenhouse reduction strategies (including CAPAG data). In September 2008 the Western Climate Initiative announced the design of a regional cap and trade program, and in early 2008 the Midwestern Governor's Greenhouse Gas Accord was launched, including four separate initiatives to reduce greenhouse gas emissions in the region through sector based policies and measures and a regional cap and trade program.

As the LCGCC reconvenes, CCS is available to provide background on actions by these states and regions, as well as federal policy updates and implications, and to assist in consideration of next steps for development and adoption of climate change mitigation and adaptation strategies in North Carolina and the Southern region.

Table 1. Southern Climate Mitigation Action Plans Completed 2007-2008[2]

State	State GHG Growth 1990-2020	% GHG Reduction Below 2020 BAU	% GHG Reduction Above/Below 1990 Levels	Estimated Cost/Savings Per Ton GHG Removed	Net Cost/Savings
Arkansas	63%	37%	5%	$10	$4.5 billion 2007-2020
Florida	70%	49%	-12%	-$18	$28 billion savings 2007-2025
Maryland	41%	56%	-38%	-$3	$2-4 billion savings 2007-2025
North Carolina	88%	47%	1%	-$6	$5.0 billion savings 2007-2020
South Carolina	87%	49%	-4%	$5	$1.8 billion 2008-2020

[2] These plans were completed with facilitative and technical support by the Center for Climate Strategies.

Figure 1. National Projection of 20 State Climate Change Action Plans

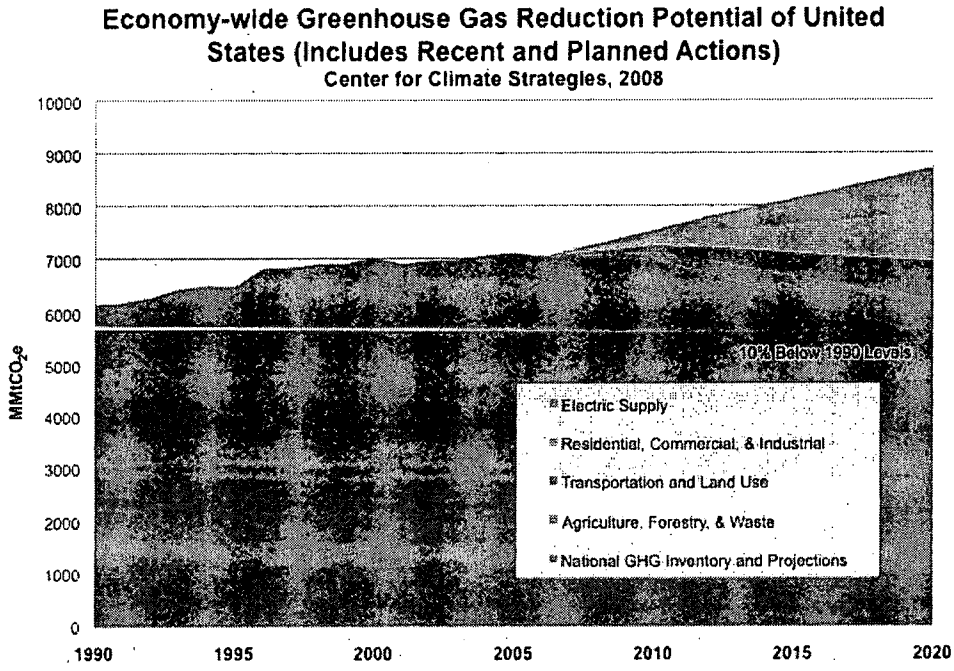
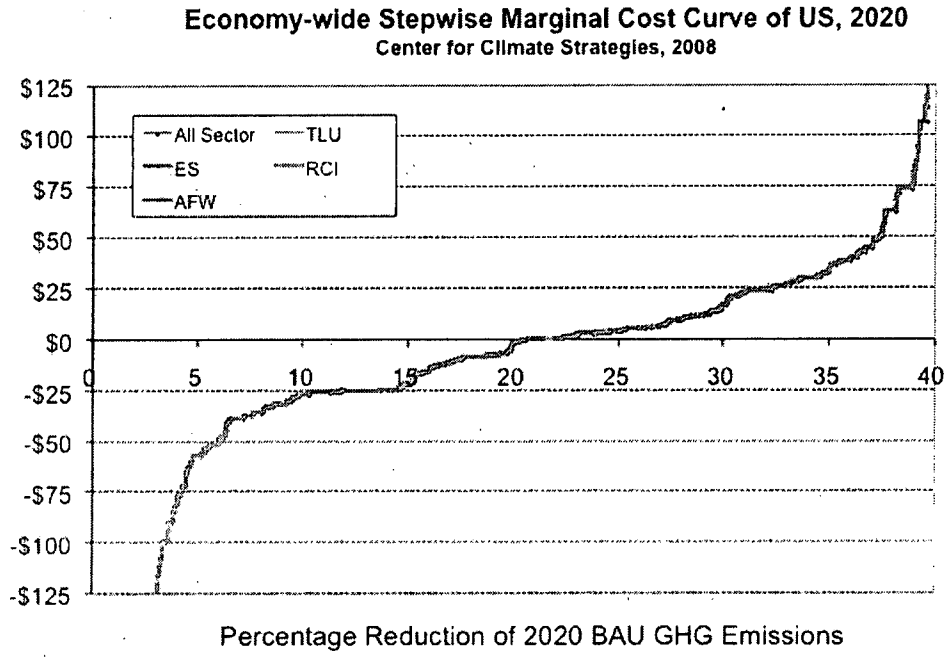


Figure 2. Economy Wide Cost Curve from 20 State Climate Change Action Plans



Peer Review

David G. Tuerck, *et al.*, *The Economics of Climate Change Legislation in North Carolina*, The Beacon Hill Institute at Suffolk University, April 2008.

The North Carolina Climate Action Plan Advisory Group (CAPAG), assembled in 2006, was tasked with the formulation of policy recommendations for reducing greenhouse gas (GHG) emissions in North Carolina, with an emphasis on strategies that would bring economic benefits.

CAPAG released a draft report for public comment, and a supplemental analysis was provided by the Appalachian State University (ASU) Energy Center to explore economic implications of the recommended energy policies. In response, the John Locke Foundation contracted The Beacon Hill Institute at Suffolk University (BHI) in Boston to critique and offer an alternative analysis to both the CAPAG report and the ASU study.

The result was BHI's *The Economics of Climate Change in Legislation in North Carolina*. The following are evaluations of this BHI critique and analysis provided by four peer reviewers.

Reviewer #1

Overview

This report has been prepared by the Beacon Hill Institute (BHI) at Suffolk University as a check on the results and recommendations of two other reports and work products dealing with climate mitigation strategies for North Carolina. These include reports and work products by the State's Climate Action Plan Advisory Group (CAPAG) and a supplemental analysis by the Appalachian State University (ASU) Energy Center, which bases its modeling on CAPAG and an input-output model developed at ASU to explore economic implications of energy policies. The BHI report presents deviations from these other reports in three main ways. It is based on a different modeling approach, uses different data, and arrives at rather contrary results.

The present review attempts to put in perspective the different approaches and BHI's criticism that the findings from both CAPAG and ASU are faulty. Specifically, BHI posits that CAPAG inadequately quantified benefits from mitigation strategies, and misrepresented and underestimated costs. It further posits that the ASU analysis is based on a flawed methodology and overly optimistic assumptions, resulting in inflated estimates of benefits to North Carolina from climate mitigation.

Instead of explicitly comparing the different reports – their methodologies, data choices, model specifications and results – this review focuses on the merits and shortcomings of the BHI analysis, while a compendium review does the same for the ASU report.

Methodology

The BHI analysis focuses on a small subset of the 56 policy recommendations chosen by the CAPAG – those dealing with Energy Demand and Supply, Transportation, and Cap and Trade. These were chosen because they account for more than 50 percent of the greenhouse gas (GHG) emissions reductions and most of the costs savings identified by CAPAG.

To assess the economic impacts of policy options in these three categories of GHG mitigation strategies, BHI used its own computable general equilibrium (CGE) model of the North Carolina state economy (dubbed NC-STAMP for North Carolina State Tax Analysis Modeling Program). Much like similar CGE models developed for regional, national and global economic processes, NC-STAMP model captures the state economy through a set of simultaneous equations representing demand and supply of goods and services and postulating that within any given period of time (in this case a snap shot for every five years of the economy) all markets clear, and all producers maximize profits and consumers maximize utility. The model is calibrated for a base year and then "set loose" to achieve equilibrium conditions in future years by solving for price vectors that achieve market clearing under new regulatory, legislative and technological conditions.

Computable general equilibrium models have been hailed for their ability to deal with the recursive adjustment processes across the multitude of sectors and households in an economy. They have, however, also been widely criticized for their often naïve representation of economic drivers – profit and utility maximization – usually under assumptions of perfect competition and zero foresight among economic decision makers. The presence of market power – which is especially pronounced in regional energy markets, even if they are deregulated – and the ability of households and firms (including electric utilities and transmission and distribution companies) to anticipate policies (especially those widely discussed and debated climate mitigation options), seriously limit the applicability of the present CGE approach. CGE models further suffer from the fact that they are usually calibrated for a base year, and – aside from criteria for convergence towards some market equilibrium – provide few (internal) measures of the reasonability of the output they generate.

The rather limited ability in the NC-STAMP model of consumers and producers to change their behaviors and technologies, as expressed in purchases of goods, services and the energy needed in their production, plus direct energy consumption for space heating, transportation, etc., result in only limited abilities of the state economy to reduce GHG emissions. Similarly, because changes in behaviors and technologies are limited, the costs, which are incurred, when climate change policies are enacted, are high. Firms are pretty much stuck with their technologies, but cost of energy rises. Households do not change their preferences or behaviors, and similarly face rising costs to meet their needs and wants. No wonder that the model generates significant losses to the state economy – in terms of reductions in Gross State Product (GSP), investment, employment, disposable income and tax revenue.

To illustrate the implications of the various model assumptions, consider the way in which the NC-STAMP model specifies investments and utilizes fixed price elasticities of demand. Steady-state investment rates are derived from the average nominal US gross domestic investment for the period 1929-2004. Patterns of gross investment by destination (such as utilities, industry, etc.) are established on the basis of historical data form the Bureau of Economic Analysis. Price elasticities are taken "from the scientific literature", though it is not quite clear why specific values have been chosen from the wide range of available estimates, and whether sufficient attention has been given to the distinction between short- and long-run elasticities.

Together, these two sets of parameters "freeze" the basic behaviors of producers and consumers to remain consistent with past observations. For example, investments continue to get funneled into sectors to mirror historical patterns. However, it can be argued that the changes in the structure and functioning of the economy, the use and deployment of new technology, and the preferences that guide consumer behavior will be changed in ways that deviate fundamentally from historical averages and trends. Energy does not even enter the mathematical description of production processes – industrial output is only generated from labor and capital alone. As a consequence, the NC-STAMP model, in its current configuration and parameterization, shows only limited abilities to allow for the broader-ranging changes in the economy that are intended with,

and may come from, policies that stimulate energy efficiency improvements and fuel switching.

Summary and Conclusions

Every model is a simplification of reality. Its value derives from an ability to organize existing information and "look into the future," though that value declines, the less the future, and the data that describe it, are consistent with the past and present on which the model is based. The NC-STAMP model, and the CAPAC and ASU studies, which it attempts to correct, all suffer from that constraint.

The CAPAC and ASU studies are criticized by BHI for their optimistic use of assumptions and selection of data. Conversely, one could argue that the CAPAG and ASU studies choose data and assumptions that are consistent with the more vigorous technological and behavioral changes in the economy that result from climate change policies, thus partially overcoming some of the constraints imposed by the input-output model on which these studies are based.

In contrast, to the ASU analysis, the NC-STAMP model is based on technological and behavioral parameters that are closely anchored on historically low rates of efficiency improvements. Choice of data and model parameters aside, the computable general equilibrium approach of the NC-STAMP model, and the associated simplifications of the underlying market form (perfectly competitive), consumer preferences (fixed), technical change (limited), and representation of production processes (energy not an input), seriously reduce its value in capturing rapid behavioral and technological changes. This holds particularly for the wide-ranging climate change policies envisioned by North Carolina's Legislative Commission on Global Climate Change.

Reviewer #2

Baseline Scenarios

A challenge in performing policy modeling work is in determining the baseline business as usual case. In particular, two major factors have changed since the CAPAG process was completed and identified 56 policy options. The first is the passage in December 2007 of the landmark Energy Independence and Security Act (EISA) of 2007. The EISA increases the Corporate Automotive Fuel Efficiency (CAFE) standards of the US light-duty vehicle fleet from the 2007 (combined) level of about 25 miles-per-gallon (MPG) to 35 MPG by 2020 – a 40% increase. The EISA also extends and increases the renewable fuel standard (P.L. 109-58 §1501) to require 9.0 billion gallons in 2008 rising to 36 billion gallons by 2022 of renewable transportation fuels. By 2015, the conventional biofuel requirements are 15 billion gallons per year. From 2016 on, all of the increase in renewable fuels must be met with advanced biofuels, defined as cellulosic ethanol and other biofuels derived from feedstocks other than corn starch (such as municipal waste or sugar).

Thus, there is a real question as to how to treat the economic impacts of the fuel efficiency, fleet mix and alternative fuel provisions in both the ASU and BHI studies. In particular, one could argue that options TLU-5 (Tailpipe GHG Standard) and TLU-6 (Biofuels Bundle) should be considered in the baseline business as usual case and the economic impacts of these measures should not be credited or debited to the CAPAG policy options.

The second major change is the rise in the cost of petroleum. This historic increase changes impacts of option TLU-3b (Rebates/Feebates to Change Fleet Mix) because of voluntary decisions by vehicle manufacturers to offer more fuel-efficient vehicles. Ford and General Motors have each made announcements to this effect. This also lowers the net costs of Tailpipe GHG Emission Standards (TLU-5) and Multi-modal Transportation Promotion (TLU-1B); other mitigation options are also likely to be affected.

The evaluation of the economic impacts of the GHG mitigation options identified by CAPAG is a very complex undertaking requiring significant professional experience and judgment. The uncertainties in effectiveness and costs of the mitigation options add to the complexity of modeling their economic impacts. The differences in estimated outcomes between the ASU and BHI studies are the result of different modeling approaches, assumptions with respect to input data, timeframes, and scope of coverage (how many, and which mitigation options are examined). Both studies could use improvement or revision, particularly with respect to recognizing changes in base case assumptions due to the recent national energy legislation and current high world oil prices.

BHI's Analysis of ASU's Study

In its report, BHI states that the Economic Impact Analysis (EIA) performed by Appalachian State University Energy Center "contains serious methodological flaws," and, in contrast to the EIA, BHI finds that eight of the options responsible for more than half of the estimated GHG emission reductions will have a negative economic impact on North Carolina's economy. In particular, by 2011, BHI estimates that implementing the eight proposals would cost North Carolina 33 thousand jobs and reduce state GDP by $4.5 billion.

The BHI study asserts that the ASU report's use of multiplier analysis is not appropriate to evaluate the anticipated policy changes. BHI makes this statement because it claims that North Carolina is in a "full-employment context". Strictly speaking, if an economy is fully employing all resources (capital, labor, land, energy, technology), and no additional resources can be attracted to that economy, then BHI is correct. Additional public (or private) investments will not induce additional economic output. However, this assessment of full-employment is overly simplistic and misleading.

According to the North Carolina Commission on Workforce Development, the North Carolina economy is transforming in many ways and involves the State's shift from one based on traditional manufacturing to a new economy driven by knowledge-intensive, business service activities. The workforce development report notes that between 2002-2005 North Carolina lost 72,000 jobs in manufacturing (p. iii). At the same time North Carolina's economy is creating many new high-skill, high-wage jobs, primarily in urban hubs. The result is that metropolitan hubs are facing a labor shortage while workers in some rural areas have to settle for underemployment, extended commuting or relocation.

Overall, the workforce report projects that 700,000 more jobs will be created by 2017 (p. 12). In short, a fair characterization of the North Carolina economy is one in transition, not one of fully employed resources with no ability to grow. In its own modeling, BHI (p. 35) notes that it assumes annual growth rates in investment, population and inflation of 1.31%, 1.7% and 3% respectively. These growth rates imply the ability of North Carolina's economy to expand.

A related question when using an IMPLAN-based model, as used in the ASU study, is whether the size of modeled changes are so large as to change the basic structure of the economy on which the model (and data) is itself based. If this is the case, then an IMPLAN-based analysis (such as conducted by ASU) is not appropriate and other estimation techniques such as computable general equilibrium modeling (such as undertaken by BHI) or structural macroeconomic modeling using time series data, would be more appropriate. ASU estimates $5.7 billion in direct and $7.5 billion in total economic impacts from the (90% of the estimated) GHG emissions reductions identified by CAPAG. These impacts are not large compared to North Carolina's GDP of $371 billion. EIA's estimated employment impacts of 32,000 are quite small compared to the estimated growth of 700 thousand new jobs estimated by the Workforce Commission and its overall labor pool of 3.4 million people in private non-farm employment.

The use of an IMPLAN-based modeling approach is, therefore, reasonable for these magnitudes of policy changes relative to the North Carolina's economy as a whole.

BHI's Results

In many instances it is difficult to fully understand how BHI arrived at their cost estimates and how they directly compare with the options outlined by CAPAG. This is because the timeframes of the analyses and scopes of mitigation options differ.

Perhaps the most important example of this is BHI's analysis of the Cap-and-Trade program, which BHI states "would produce the most damage to the North Carolina economy (p.22)." BHI states (p. 17) that it based its analysis of the Cap and Trade program for CO2 emissions on the federal legislation America's Climate Security Act (CSA) of 2007 (S.2191). According to BHI, this Act's target is to reduce GHG emissions 70% below 2005 levels by 2050.

This presents a couple of difficulties. First, it is not at all clear that the level of emission reductions (and costs) posited under the CAPAG program are the same as modeled under the CSA. Second, the timeframes of analysis are not the same. BHI provides cost estimates for the 2006-2011 time period, while the CAPAG scenarios are based on a 2007-2020 analysis, and the CSA has a 2050 target. Generally speaking, the greater the level and speed of emission reductions, the greater the costs of GHG mitigation. It is widely accepted in the economics community that appropriate treatment of technical change and learning by doing are crucial for modeling large, long-term reductions in GHG emissions.

Thus, it is difficult to place much, if any, confidence on BHI's cost estimates of the CSA for a single state for a 5 year time horizon that seeks to model a program anticipating national implementation out to 2050.

In describing ES-4 Cap and Trade, the report notes that the value of permits "depends on the number issued." This is only partially correct, the value of permits depends on the number issued and demanded by regulated sectors. (p. 16)

Notwithstanding my general comments about the baseline assumed due to the passage of EISA, BHI's cost estimates to implement TLU-5 are unreasonably large. In estimating the cost of tailpipe standards, BHI uses a technology cost estimate of $2000 and gasoline savings of $1000 per new car. BHI then imposes a $1000 per car cost on all new vehicles estimated to be sold in North Carolina from 2006-2011. Both the technology and fuel cost estimates are likely to be incorrect for several reasons: timing of implementation, overly pessimistic assumptions concerning technology costs, fuel prices that are (probably) too low, and lack of sectoral detail in the CGE model to accommodate sales mix changes from consumer behavior. (p. 27)

a) Timing: instantly forcing new vehicles to be more fuel efficient is very expensive. However, California legislation and EISA (discussed above) have phase-in schedules. This is because manufacturers typically require 3-5 years to redesign vehicles and several

additional years to change platforms and production lines. The imposed $1000 per vehicle cost used in this CGE model is simply not a reasonable depiction of costs associated with phasing in tighter fuel efficiency standards.

b) Probably the best publicly available data on the costs of increasing fuel efficiency comes from the National Highway Traffic Safety Administration in the Notice of Proposed Rulemaking and Preliminary Regulatory Impact Analysis published pursuant to EISA. The Notice of Proposed Rulemaking which covers the years 2011 to 2015 (implementing a 40% increase in fuel economy by 2020) shows the average technology costs for cars to be $276 (2011) - $649 (2015) and trucks $224 (2011) - $979 (2015). The rate of increase in fuel efficiency for the fleet over this period is 4.5% per year. Later year cost estimates are not currently available from NHTSA.

These costs estimates are superior to others because they are based on the peer-reviewed study by the National Research Council augmented by proprietary data on vehicle manufacturer's planned production and current use of fuel economy technology. On a national level, taking into consideration wider social factors, NHTSA summarizes (p. 17): "We estimate that the value of the total benefits of the proposed passenger car standards would be approximately $31 billion over the lifetime of the 5 model years combined. This estimate of societal benefits includes direct impacts from lower fuel consumption as well as externalities and also reflects offsetting societal costs resulting from the rebound effect." For light Trucks the comparable estimated savings are $57 billion.

c) These benefits, as calculated by NHTSA, reflect gasoline prices in $2.50 range. BHI does not specifically list the assumed price of gasoline. BHI's CGE model is benchmarked to EIA's Annual Energy Outlook 2008 (early release) that forecast petroleum in the $60-$70 per barrel range. Petroleum prices are extremely difficult to predict, but currently sell on the spot market for about $130 per barrel. Changes in the costs of fuel will have a very significant impact on the cost effectiveness of increased fuel economy standards. This will affect the net benefits and costs as estimated by NHTSA and BHI.

The elasticity estimates used in BHI's model to calculate how price effects imports and exports are based on published literature that is 15 years (Roland-Holst et al.) and 18 years (Reinert & Roland-Holst) old. These elasticities reflect pre-NAFTA data. I do not know if newer data exist, but state-specific CGE models face this data limitation. (p.61)

In summary, the BHI study is uses a combination of overly pessimistic cost assumptions, unrealistic phase-in schedules and does not well represent the costs of obtaining the mitigation options identified by CAPAG.

If I can be of any additional assistance, please let me know.

Reviewer #3:

Main Comments:

1. There are a number of examples of mis-representation or obfuscation by BHI that leads one to question BHI's objectives. For example, CAPAG describes itself on its own web site this way: "The North Carolina Climate Action Plan Advisory Group (CAPAG) was formed as an advisory group to the NC Department of Environment and Natural Resources (DENR) administered by its Division of Air Quality (DAQ) with assistance and facilitation from the Center for Climate Strategies. North Carolina's CAPAG was charged with (1) developing an inventory and forecast of greenhouse gas emissions in North Carolina and (2) developing recommendations to reduce the state's greenhouse gas emissions." [1]

   BHI's characterization of CAPAG is different: "...the North Carolina Climate Action Plan Advisory Group (CAPAG), which describes itself as "a voluntary advisory group to the NC Department of Environment and Natural Resources (DENR) ... administered by its Division of Air Quality (DAQ) with assistance and facilitation from the Center for Climate Strategies (CCS). CAPAG charged itself with developing an action plan with recommendations to reduce the state's greenhouse gas emissions, coordinating with the LCGCC in the process." (BHI, pg 2).

   The descriptions, while similar, result in very different pictures of the CAPAG.

2. BHI emphasizes problems with the ASUEC methodology of Input-Output (I-O) analysis as not being appropriate for the task at hand. They propose the use of Computable General Equilibrium (CGE) analysis. Different modeling approaches inherently have different implicit restrictions and assumptions. To provide a useful alternative, the methodology, using the same initial data assumptions and time horizons, is necessary. BHI changes the methodology, select data and assumptions, and the time horizon. In addition, they assume a Cap-and-Trade format. The results cannot be compared to the CAPAG results.

3. The analysis is purported to "provide independent estimates of the economic and fiscal impact of selected CAPAG proposals" (BHI, pg 5). The contract isn't provided in the document, and no further details of the contract are provided.

Overview

Overall, there are a number of inconsistencies, misrepresentations, and errors in the document. In fact, these all fall so much to one side of the issue that this document presents as an advocacy piece, rather than "independent" research and

[1] http://www.ncclimatechange.us/capag.cfm (last accessed 07/26/08).

caused me to seek out the missions of both the John Locke Foundation and BHI.[2] Both are grounded in limited government and free market principles, lending validity to the observation that the analysis is one-sided in favor of limited or no regulation.

BHI's Criticism of CAPAG Results

The BHI criticisms fall into two primary categories:

1. Methodological (modeling approach).

2. Assumptions on policy, information, and data used as inputs into the models.

BHI criticizes the assumptions and modeling approach of CAPAG. The criticisms range from the inappropriate modeling technique to inappropriate assumptions and restrictions (BHI, pg 10). The problems can be alleviated with the use of a GCE model, according to BHI. However, there are as many restrictions and assumptions associated with a CGE model as an I-O model. The superiority of one over the other is stated, not demonstrated. Superiority is assumed and results presented.

Naturally, there is no reason to expect the same outcomes from different modeling approaches, but should one expect the great divergence in results from the modeling approaches? It is not likely, but then this doesn't have to just be conjecture, this is certainly testable. If BHI were interested in research to compare the approaches, the same underlying assumptions would have been used as a base case to judge what differences would be produced by the modeling methodology alone. Then the difference in information, policy, and data could actually be ascertained. In the current form, the modeling outcomes cannot be compared and no conjectures can be made. We can simply state that given different modeling techniques, different assumptions and different time horizons, there are substantially different results.

BHI Methods and Results

BHI analyzes only 8 of CAPAG's 56 recommendations and only for a subset of years considered by CAPAG and ASUEC. Therefore, the BHI analysis is not

[2] The John Locke Foundation mission is stated as "...employs research, journalism, and outreach programs to transform government through competition, innovation, personal freedom, and personal responsibility. JLF seeks a better balance between the public sector and private institutions of family, faith, community, and enterprise." From http://www.johnlocke.org/about/ (last accessed 07/26/08). BHI's mission is stated as "Grounded in the principles of limited government, fiscal responsibility and free markets, the Beacon Hill Institute engages in rigorous economic research and conducts educational programs for the purpose of producing and disseminating readable analyses of current public policy issues to voters, taxpayers, opinion leaders and policy makers. From: http://www.beaconhill.org/Mission.html (last accessed 07/26/08).

complete at the start. While their criticism of I-O modeling has some merit, from the information presented on the BHI STAMP model, it is not clear that we should have any more confidence in STAMP. Regardless of the modeling approach chosen, both require data and parameter value inputs to produce their predictions.

Appendix B, which describes the NC-STAMP CGE model, p. 35, "If citizens of North Carolina save more than they spend, then the excess savings will leak out of the state." This implies that citizens' savings will have a negative or, at best, no impact on the NC economy. However, a contradictory definition of savings is presented on p. 44, where income less taxes and spending equal savings.

Page 36, it is stated "NC – STAMP is a policy model and not a forecasting model." Yet forecasting (predicting) is exactly what is being done here. That is, the impact of policies are being forecast and numerical point estimates associated with their version of a policy under assumptions they prefer are provided.

A steady state is assumed on page 35. However, it is not indicated what is to be considered a steady state. They apply fixed growth rates for investment, population, employment, and inflation over the limited time horizon they consider. Given the nature and obfuscation of such assumptions, it is interesting to note that criticisms of others leveled by BHI also apply to BHI's work.

Page 36, the economy is assumed to be competitive and operating at full employment. They are in fact assuming that the economy is efficient initially and any movement from this position is inefficient, hence their large negative predicted values in applying their model (under their particular assumptions). The economy can only be competitive if all externalities are internalized (see any credible microeconomics text), thus their assumption itself is a contradiction to analyzing environmental policy. From the information provided, it appears their assumptions leave no room for the possibility that the policies considered could be helpful (unless they lead to a tax or fee cut).

Page 41, regarding the linkages between NC and the rest of the economy "is an area where considerable professional judgment was required." This sentiment is reiterated in the document (e.g., p. 44). BHI is arguing that their professional judgment is right, while criticizing others' judgment on many issues. It is unfortunate that BHI didn't report information, or perform the analysis, in such a way that the separate effects of modeling, data assumptions, and "professional judgment" could be evaluated. In fact, as illustrated in some of my comments above, much of the criticism BHI level could apply to their analysis as well.

Review #4:

The Beacon Hill Report attacks the CAPAG reports in three erroneous ways: (1) Not meaningfully comparing benefits to costs; (2) misinterpreting costs as benefits; and (3) understating "true" costs. As I explain below BHI is mostly off the mark on their economic interpretation and criticism of the CAPAG Reports.

Regardless of the specific criticisms, BHI forecasts a loss in jobs, reduced income and lower NC GDP.

The BH Report also specifically criticized ASU for:

(1) using multipliers with full employment; (I doubt in mid 2008 many would side with BH given our nation's current economic woes.)
(2) using flat electricity prices' (The state's utilities do quite well with prices about half those found in parts of New England, the Northeast and California. The BH may need to fix its frame of reference for NC.)
(3) investment may be too optimistic in an I/O context; (This could be said about most models unless investment is endogenous.)
(4) evolution of energy costs overtime is implausible: (This is why sensitively analyses, not finger pointing should be used.)

Who is correct?

(A) BHI treats the money spent in a Public Benefits Change (PBC) as a "Tax". Treated as a tax this would cause the North Carolina economy and employment to fall. BHI calls these measures a cost and ignores the likely greater and well-known benefits that follow from reduced GHGs.

The CAPAG Report treats a PBC as a fee to encourage cost savings reductions in energy use. These energy efficiency programs would reduce household and business expenses, free up money to spend on other things causing the NC economy and employment to grow.

The CAPAG group has the better set of facts. Efficiency improves welfare and economic growth, as well as reducing negative externalities and their related compliance costs for: GHGs, other pollution, and economic and national security.

(B) BHI reaches similar false conclusions in the transportation sector because they ignore how saving GHG with improved transportation also saves money on fuel and reduces the losses to the economy from imported oil as well as improving environmental quality. The CAPAG are again the conceptually more correct analysts.

(C) The discussion of CAP and Trade in the BHI Report has several flaws. It does not address how allowances are distributed. This is a major flaw and causes "Big Costs" in the manner BHI implicitly assumes all CAPS would be purchased. Second, Cap and

Trade is a means to lower compliance costs. This would create benefits. Third, GHG and related factors, such as other pollution and energy imports, cause negative externalities and/or hurt the economy.

BHI gives no weight or value that the net gains from Cap and Trade conceptually include: the economic efficiency related to least cost compliance; as well as the reduction of negative externalities and social costs.

The BHI also prepared a power point restating the conclusions in their Report. Both Reports attempt to convince people to push back on efforts to address current environment, energy and economic challenges. They fail to say what they would do instead and do not consider the costs and consequences of I guess doing nothing. CAPAG sharpen the understanding and lays out reasonable options to act and to remove muddling through as an option. Lets see: do nothing, muddle or a path to act. There is no real debate here. CAPAG trumps BH.

CONCLUSION

The CAPAG Reports demonstrate a cost effective vision for NC to reduce GHGs virtually to 1990 levels and make other improvements. BHI tries to make this discussion about the precise measurement and size of benefits. They, not CAPAG, omit most benefits and call the cost effective means to the end a tax. This is not sensible or conceptually sound. I would accept the CAPAG Reports and reject as biased and misleading the BHI Reports.

A Note on the Peer Reviews:

The reviews were commissioned by the Center for Climate Strategies. CCS engaged Adam Rose (Ph.D. in Economics from Cornell University), as a private consultant to coordinate the review process. Dr. Rose is a a leading environmental energy economist, He served as Professor and Head of the Department of Energy and Environmental Economics at Penn State University for 14 years, and is currently a Research Professor in the School of Policy, Planning and Development at the University of Southern California.

Professor Rose arranged for four independent experts to review the BHI report *The Economics of Climate Change Legislation in North Carolina.* Three of the reviewers were from academia: tenured professors from the Department of Economics at the University of Maine and at the University of New Mexico, and from the School of Public Policy at University of Maryland. One reviewer was from a business setting – from the Pacific Economics Group, a management consulting firm with offices in Madison, Wisconsin, and Pasadena, California.

For more information about the peer reviews, please contact Professor Rose at azr1@psu.edu.

Florida Department of Environmental Protection
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Charlie Crist
Governor

Jeff Kottkamp
Lt. Governor

Michael W. Sole
Secretary

November 5, 2008

Mr. J. Robert "Bob" McClure, III
President and CEO
The James Madison Institute
Box 37460
Tallahassee, Florida 32315

Dear Mr. McClure:

I am writing in response to your letter regarding the James Madison Institute's (JMI) recently published *Backgrounder*, "Phase II of Florida's Plan for Energy and Climate Change: Avoiding the Mistakes Made by Others." As your organization requested of us, my staff provided copies of this document to the Action Team members prior to our final deliberations in October.

Let me start by noting that in my service as the appointed Chairman for the work of the Governor's Action Team on Energy and Climate Change (Action Team), I took every available opportunity to ensure that public comments were actively solicited, encouraged, heard, and considered prior to every vote taken by the Action Team and at times in between. I and the 28 members of the Action Team have welcomed any and all intellectually honest critiques of the processes, assumptions, and analytical techniques that the Action Team, its staff, and/or the independent technical support team utilized in developing policy recommendations for the Final Report. As you know, that Final Report was delivered to Governor Crist on October 15, as tasked and outlined in Executive Order 07-128 last year.

The Action Team held with utmost care and concern the integrity of the analyses used in our processes. If you were able to observe our proceedings, I believe the members' regular and repeated examination of analytical results was both clear and helped ensure that the assumptions and the parameters used were fully vetted and understood. In fact, you may recall it was not rare for members to request recalculations to ensure that the analysis reflected the best information or data sets available. I was proud of this determination and commitment to the final product and to selecting whichever recommendations were brought to us by the six Technical Working Groups.

It has been said that Florida had the most rigorous and open, facilitated process of any state to undertake this level of work to date. In the Phase 2 process alone (calendar year 2008), the 28 Action Team members met nine times, representing more than 60 hours of

deliberation as a full group. The 122 appointed members of the six Technical Working Groups met more than 71 times on toll-free, public access conference calls, representing more than 155 hours of combined meeting time, in order to bring recommendations forth to the Action Team. Of course, none of this counts staff time, individual requests of any appointees for information and appointees' own respective reading and evaluation time to be prepared for our public meetings.

With that said, I truly wish to express my disappointment in a significant number of themes and statements in the policy paper you produced that was directed at the process we employed. For example, in the Foreword of the *Backgrounder* it alleges the Action Team's Phase 1 Report contains "serious methodological flaws," for which the Center for Climate Strategies (CCS) is responsible. The factual situation is that CCS was not involved with Phase 1 process. CCS was contracted in 2008 only for the Action Team's facilitated Phase 2 process with the Technical Working Groups. Many of the other statements made by the author writing under the JMI marquee (Mr. Bachman of the Beacon Hill Institute) are as remarkable as they are cursory. For instance, your author asserts that new jobs cannot be quantified as benefits to Florida's economy because this would divert those employed in other sectors; however, this could be true only if Florida's economy was at full employment and every employee was employed at his or her fullest potential.

Mr. Bachman also asserts that increased energy efficiency cannot be assumed to have positive benefits to Florida's economy because if such benefits existed, they would have already been realized. This would be true in the case of perfect competition, where no market failures exist and everything is constantly in balance for supply and demand all of which we know is not the case. I truly believe that the Action Team's Final Report - the Florida Energy and Climate Action Plan - is a science-driven and realistic albeit ambitious blueprint. I know JMI must, hopefully, support the notion that Florida cannot afford to be left behind in this grand economic opportunity, and that we must prepare ourselves to address and avert our greenhouse gas emissions and develop new forms of renewable energy to better protect our environment.

The opening of your letter to me on September 8 indicated that the Action Team had been focusing on the environmental and energy policy issues and not on the economic impact of the proposals; however, I cannot recall one meeting since 2007 where the two issues were not discussed in tandem for each item on our agenda at each meeting. Our Final Report - which was well under way in final and publicly released draft form before the JMI *Backgrounder* was released - is replete with economic considerations.

As Florida moves forward by embracing the strategic and economic opportunities embedded in the challenges of global climate change, including energy security, I

would truly welcome more thoughtful policy analysis from the James Madison Institute. I greatly appreciate alternative views toward solving our collective problems, but the *Backgrounder* did not do the public service that the JMI aspires to and has delivered in other cases.

I have taken note that your short-term plans also include a new document: "Policy Brief - Are 'alternative energy sources' a viable solution for Florida's future needs." I hope and trust that your author(s) can avail themselves of the expert program staff at DEP and the Governor's Energy Office before writing your conclusions. I believe we attempted to reach out several times over the summer to you and JMI before the recently released *Backgrounder* was published; so I repeat that invitation and offer, to ensure the best facts are drawn forward for the public and for decision-makers before you develop your next "Policy Brief."

Sincerely,

Michael W. Sole
Secretary

cc: Members, Governor's Action Team on Energy and Climate Change
Thomas M. Perrin, Director of Public Affairs, The James Madison Institute
Jeremy Susac, Esq., Executive Director, Governor's Energy Office

DRAFT

Global Climate Change Commission Meeting
Tuesday, October 23, 2007
10:00 a.m.
Room 643 LOB

The Legislative Commission on Global Climate Change met on Tuesday 23rd October in Room 643 of the Legislative Office Building with Representative Pricey Harrison, Co-Chair, presiding until Mr. Garrou arrives. Other members present were: Sen. Albertson, Sen. Cowell, Sen. Pittenger, Rep. Thomas, Rep. Underhill, Rep. Wilkins, Dr. Eggers, Mr. Tim Toben, Mr. Urlaub, Ms. Choi, Mr. Everett, Mr. Howard, Mr. Peele, Dr. Phaneuf, Mr. Profeta, Dr. Riggs, Ms. Prayer, Mr. Slocum, Dr. Smith, and Dr. Uzochukwu. The visitor registration is Exhibit A.

Representative Harrison called the meeting to order and indicated that Co-Chair, Mr. Garrou is on his way to the meeting having traffic problems on I-40 and gave the floor to Mr. Givens for introductory remarks.

Mr. Givens welcomed everyone and gave a few introductory remarks. Chairman Garrou is in route and expected to be here in another thirty minutes or so. A tractor trailer overturned that blocked all of the lanes on I-40 and that is probably what has some of the other members as well. With regard to changes in membership, I will recognize each new member and indicate if you wish to say anything. We have a continuing member who has been appointed by the Speaker to replace himself as the House Co-Chair, Rep. Pricey Harrison. We welcome you as Chair. Rep. Harrison states she is looking forward to work with everyone. Rep. Lucy Allen could not be with us today, she has been appointed to replace Rep. Harrison as a member. Rep. Charles Thomas has been appointed to replace Rep. Wilma Sherrill. Rep. Thomas said thanks and he's just glad to be here from Bumcombe Co. Jane Preyer is the Executive Director of the Environmental Defense and has appointed herself to replace Michael Shore who previously represented Environmental Defense and has moved on to other employment. Other than Rep. Allen the only other member that I know has contacted me about scheduling conflict and not being able to attend is Susan Thompson. Ms. Utley has not been contacted by anyone. Mr. Givens told the members that it is always helpful when we know when you are in route or may have some difficulty in getting here and being late versus whether you can't make the meeting.

You have been given a revised membership list (Exhibit B), please look and make sure that your information is correct. If it is not correct, talk to Ms. Utley and we will correct it for you. There may be another change or two in membership caused by people resigning their academic appointment. With regards to the agenda this morning(Exhibit C), a lunch break was not scheduled hopefully we can finish before lunch. Adjournment is expected sometime

between 1 and 2. The agenda is straightforward. Our first presenter is from the PEW Center with an update on what is happening around the nation on climate change since we last had an update about a year ago, Pat Hogan will be presenting that. Agenda Item #5 - Mr. Givens will be talking about Senate Bill 3. The most important item is Item #6 – the Climate Action Plan Advisory Group met a week ago today and made its recommendations for consideration. There are 50 some of those, they will be presented by Mr. Tom Peterson.

Last you will hear from the folks at Appalachian State on what they characterize as draft preliminary results of a macroeconomic analysis. We wanted you to hear where that stands and perhaps give some guidance to that work which will be presented by David Ponder, Graduate Research Assistant.

The co-chairs have settled on some tentative meeting dates and they are on the back of your agenda. The next meeting is scheduled for the 4th of December. We can make adjustments if we find that a lot of members cannot have conflicts on a particular date.

Your attention is called particularly to the February meeting because I want you to be aware of the plans for that. The Emerging Issues Forum will be focused on energy this year. That forum will be held on Monday and Tuesday, the 11th and 12th of February. One of the speakers they expect to have is the chair of International Panel on Climate Change, the IPCC. They've just issued a new report and a recent co-recipient of the Nobel Prize. It may be that we will schedule our meeting at the McKimmon Center on Monday or Tuesday in connection with the Emerging Issues Forum. I ask you to hold those dates on your calendar and we will keep you posted and free up the dates we don't intend to use as soon as possible. I think the topic will be of great relevance to this Commission and I think it may be possible that we can work out some coordinated attendance perhaps this Commission would even be in position to pay these registration fees. I will have to investigate that.

On the matter of the Interim Report – we last met in February and we spent a good deal of time going over various recommendations and taking votes and then the staff was instructed to prepare an interim report. Chairman Hackney and Chairman Garrou felt that there need to be some further mechanism whereby you saw it one more time before the report was made. The report was placed in my box of items to be reviewed and promptly covered up by bill drafts. There is a draft interim report, it has no official standing. We are discussing what if anything to do about it, the practical accomplishment of this process is the enactment of the energy bill Senate Bill 3. Once we get in session, we have to suspend work on interim activities and we just simply don't have time.

At this time I would like to introduce to you Terry Nordon who is the vice counsel for Science and Innovation with the British Consulate General's Office in Atlanta. He is visiting us today, as you know, we've had an ongoing discussions with the

British Government and particularly the Atlanta Consulate General. They were the sponsors of the best reception that I attended during the 07 Session. Ms. Nordon.

Ms. Nordon: Good morning. Thanks for having me here.

Mr. Givens: We have a Commission website where we try to post documents relative to this Commission. Ms. Mundt informs me that we will promptly post all documents that are associated with this meeting. I encourage all visitors in the audience to sign the visitor registration. Members please get in your reimbursement forms, the quicker we get them from you the quicker you can get paid.

Chairman Harrison: At this point I would like to recognize Patrick Hogan from the PEW Center on Global Climate Change and thanks for making the trip down here.

Mr. Hogan: Thank you very much for bringing me down here today and giving me the opportunity to speak to you all. Many of you heard from my colleague Josh Resinki about this time last year in October 2006 and I took from the agenda that I am going to be giving an update on national and state level action on climate since last October. I also am going to talk a little bit about what has been going at the international level. So just to give you an overview of where we are headed and I should preface it by saying that a lot has happened in the past year so it is an awful lot to take in and I've tried to just pull out the highlights but it may seem like a bit of an information dump at times. I'll be giving some quick highlights from the international policy landscape followed by an update on federal and congressional actions here in the states including an update on what the 2006 congressional elections mean for climate in the U.S. The current policy landscape here in the U.S. and some other major initiatives at the federal level and then I will wrap up with state and local updates and tell you some of the highlights from state action from around the country.

This is really a policy update so I haven't included anything on the science. I am happy to talk about that during the Q&A session if you have any questions. But there have been a lot of development in climate science as well in the past year. Whenever you talk about climate change and climate policy at the international level it is helpful to think about how different parties come to the negotiating table and why there are such different perspectives on what different countries should adopt as their responsibilities for addressing this problem. Hopefully, I know the numbers are a little hard to read (Exhibit D) but the sketch of side by side comparisons of cumulative emissions for each of these countries as well as total annual emissions at the moment. The US is the largest annual emitter of CO_2 from energy use followed closely by China and then the 25 year countries. Together the US, China and the EU make up well over half of all the energy related CO_2 emissions in the atmosphere. Although official data is not available

yet, it looks like based on preliminary evidence and estimates that China may have actually just surpassed the US as the top annual emitter this past year. If it wasn't last year it is going to be this year or the year after, sometimes very soon. While much of the climate policy debate especially here in the US focuses on annual emissions, what really matters from a scientific perspective is cumulative emissions. Since greenhouse gases, CO_2 especially stay in the atmosphere not just for a year but for hundreds of years. So it is really that build up of gases over time that matters. If you look at the cumulative emissions side by side of the annual emissions, the US's share is closer to 30 percent and the EU's is pretty close as well, it's around 27 percent. While China has just contributed 7 percent of cumulative emissions so everything is already up there. So this evaluation of historic responsibility that shapes the demands and viewpoints of the developing nations like China when they come to international climate negotiating tables. This just offers another cut at looking at the international emissions landscape on a per capita basis. The US is about four times the world average on a per capita basis for CO_2 emissions, China is just below. Even compared to other developed nations the US is pretty out in front on this one. We on a per capita basis emit about twice as much as the European Union or Japan.

Now just to go through some of the highlights from international theme this past year, a group of eight summits in June 2007 called for a global agreement on a post 2012 framework under the UN Framework Convention on Climate Change in 2009. Within the UN itself at the end of September, there was a high level meeting held in NY with over 150 countries in attendance, many high level delegates and the goal of the meeting was to send a strong political signal to accelerate upcoming work at a meeting which I'll talk more about in just a moment. What was really evident from this meeting, unlike in many previous forums, is that by and large all of these countries are no longer questioning the science, they've really gone under the question of what to do about this issue. I think of the 150 delegates in attendance just one was saying that the science wasn't good enough there is no need to act. Everyone from the other 149 countries was saying that we need to get the ball rolling on a new framework. Of course another major international event was the meeting held just shortly after the September meeting – this was a meeting organized by the President to bring together the 15 top emitting economies that includes both developed and developing countries. What really emerged as the issue at this meeting was the distinction between voluntary versus binding commitment and who should adopt which. President Bush's vision has remained largely unchanged during his time in office and he's calling for a long term international goal, but individual countries would not be subject to any sort of binding emissions cap or commitment. The bill would be reached purely on a voluntary basis alone. At this meeting, 14 other nations present basically said this is not good enough we need binding commitments of some sort. Even China and India are saying look binding commitment doesn't necessarily mean targets for everyone but it means that every country has some sort of policy commitment to help address this issue and

they are willing to adopt some sort of policy that could help produce their energy consumption and make them more efficient.

You may have also heard another major international development very recently, former Vice-President Al Gore and the UN Intergovernmental Panel on Climate Change shared a Nobel Peace prize and I guess many of you have already seen An Inconvenient Truth. I've heard that the DVD sales are doing very well – it's been booming, but we will actually never know exactly how many copies were sold because the Supreme Court intervened to say stores have to stop counting how many people buy it. Little bit of a problem. That's a joke. The Supreme Court has done lots of stuff but not quite to that level. Looking ahead if we ask the question what's the likelihood of a new international framework coming together any time soon, it's very unlikely that real negotiations are going to happen any time before 2009. The first chance to get that process moving is this upcoming meeting in December. It's really a potential to launch a new UN process, it's the first chance for nations to come together and talk about and submit their proposals for what post 2012 framework should look like. I keep saying post 2012 because 2012 is when the Kyoto protocol commitment period expires and that is the current international framework that many nations are offered.

Just looking at some other major emitters around the world and actions that they've taken this past year – Australia has historically been pretty skeptical of taking action on climate. Of course in addition to the US they were the only other developed industrialized nation not to ratify the Kyoto protocol. However due to a number of circumstances, one of which may have been a pretty devastating drought that hit Australia this past year. They are now thinking seriously about setting a cap and trade scheme on reducing emissions through emissions trading. If that does need to go forward it will commence some time between now and 2012. New Zealand Australia's neighbor is also thinking of setting up an emissions trading scheme. European Union of course already have their scheme up and running and it is functioning pretty well. Especially considering it's a new market – the first program of its kind and it is very ambitious and it covers CO_2 emissions from over 12,000 facilities across the European economy. You can see trading volumes have been pretty high just in the first stage. The first stage which ends fairly soon, 2008, was set up as really a learning phase to help the system find its leg and get the kinks out. The Kyoto commitment period is 2008-2012 and they hope to have everything ironed out amongst the market really functioning smoothly. The EU of course has also issued some pretty aggressive statements regarding global climate as well including a 20 percent renewable portfolio standard for the EU. They are putting a lot of effort into funding carbon capture and sequestration projects and committed to reduce greenhouse gases 20 percent below the 1990 levels by 2020 and will go even further if other developed nations, mainly the US agree to similar cuts.

Leaving the rest of the world behind focusing in on what's been going on at the federal level here at home. Of course the democratic victory in the 2006 election has a lot of implications and ramifications through many policy areas but especially climate change. I will not go through all of these names but all of the key committee leadership posts in the House and Senate have been filled by democrats who have pledged to make climate change a priority and already have in many cases. The senator from California which is kind of a poster child for state action on climate change has certainly made this a priority and really wants to get a bill through her committee. She of course replaced the former chair who declared that climate change is the greater host of all times. This change in Congress is just one reason that this has been a kind of key change amongst industry and large businesses this past year as well. Not only is this increasingly recognized in the US action on climate is no longer a question of if but really a question of when. They are also starting to embrace it – this change in attitude is due to a number of factors, the democratic congress increasing likely other legislation. Of course the states are continuing to exert a large amount of pressure with all the steps that they are taking. Other countries are calling on the US to step up and take substantial leadership on this issue. US public pressure is probably at an all time high, which corresponds to a greatly increased awareness among the US public of this issue and what it could mean. There are a number of other reasons but many are starting to see it as this is coming sometimes very soon.

One of the reason it makes climate change regulate greenhouse gas regulations or legislation fairly likely is the Supreme Court's decision from earlier this year in MA et al. vs. EPA which many of you may have heard about. Especially in this case, MA several other groups sued the federal EPA for not regulating emissions of four greenhouse gases especially CO_2 from the transportation sector, auguring that under the clean air act EPA had not only authority but a duty to regulate these air pollutants since they threaten public health and welfare. The EPA of course said the opposite, we don't have the authority to regulate these gases, it is not our responsibility. Ultimately the Supreme Court sided with the states in what is pretty landmark ruling. The court ruled that the EPA not only has the authority to regulate CO_2 and other greenhouse gases under the clean air act, but that the EPA has a duty to protect public health and welfare under the act. Essentially told them you need to go away and rethink your position and once you can come up with a really good excuse for not regulating these gases you need to do so. Essentially the EPA would have to prove that CO_2 and other greenhouse gases don't cause climate change which at this point would be pretty difficult to do. This obviously has implications for potential regulation of the vehicles and stationary sources by the EPA, and also implications for a CA proposed greenhouse gas standard for vehicles.

I had mentioned before that businesses are starting to wake up and are not only seeing climate legislation as very likely but are also looking to embrace it and thinking it could be a good thing. Probably no where has it been more evident

than in the US Climate Action Partnership which you may have also heard about emerging with (inaudible) I believe. Initially this was a group of about 14 including several large major players in business and industry from every sector of the economy. It includes major utilities, oil companies, auto manufacturers, and a host of others. The partnership started with some of these companies and a hand full of (inaudible) including the PEW Center. Since the initial inception the US cap has grown substantially – it now has 33 members total, 27 of which are as large corporations. US cap emerging goal and with what they're calling for is rapid enactment of legislation at the federal level that creates a mandatory but flexible climate program. It includes some sort of market program especially cap and trade that reduces emissions on a steadily declining float towards 2050 and promote technology research development and appointments. The important thing about the US cap target that these businesses have endorsed is that they are informed by where the sciences simply need to be based on the latest science. In order to avoid dangerous build up of greenhouse gases that can lead to really unpredictable and potentially dangerous climate change, we need to reduce emissions somewhere between 60 and 80 percent from current levels by this century. US cap targets call for a long term target in that area.

I am not going to run through everything on this slide because it is very wordy. I think it is important to look at this and think about the contrast between the current situation encountered and how things were in the 109th – it's a very different story in the 110th. There have already been less than a year in the current congress over 125 bills, amendments and resolutions related to climate including a record number of cap and trade system proposals, and this combined with a number of hearings if you compare that to action in the 109th across two years, I don't think the number came anywhere near that, so that's pretty significant. Action in the congress in the 110th is also included the formation of select committee on energy and the effects of global warming in the House. So I am not going to go into great detail on a lot of the specific bills other than to illustrate how they stack up. The one pretty significant piece of legislation that was just released last week is a new proposal from Senators Lieberman and Warner. And it is significant is not leaked because it is bipartisan in nature and has a pretty decent chance of passage and getting out of the Environment and Public Work Committee. The bill is sponsored by the two senators listed above and by several others on both sides of the isle as well and I should note that includes NC Senator Elizabeth Dole. The Lieberman-Warner bill would basically take a very strong step towards getting the US where it needs to be in terms of emissions reduction. It was set up in an economy wide cap and trade program covering transportation fuels, utilities and other large sources are also driving climate friendly technology development and innovation. The target would establish our ambitious yet certainly achievable – they get up to kind of a low end of where the science that we need to be about 65 percent below current levels by 2050.

I am not going to read the individual names here but this just shows how the six major cap and trade proposals in the Senate stack up against one another in historical emissions or business as usual emissions. So if we continue to do nothing we will end up on this sort of deep red clarifying slope that goes off into infinity – that is what we really want to avoid. You can see that the six major proposals in the Senate basically all get us more or less where we need to be. Some of them have more or a declining slope over time, some take more of a step approach but really they all get us to where we need to be in the long term. You can also see in the graph the US cap recommended target represented by the grey band that a lot of the bills fall into. If the safety valve is hit then the Bingaman bill would look pretty different and probably would not get us the emissions reduction we need.

Now we are going to leave the Senate behind and get onto what I think is really the most exciting stuff going on around the country. The site wise this might look like it is not a matter of congressional redistricting gone terribly wrong, this is just to make a point that sometimes when I start talking about state action and climate people raise the question "Why does that matter?" and in the states are tiny, how can their emissions production make a difference? The truth is that state emissions are pretty significant – they're significant contributors to the problem and can contribute significantly to a solution. So the numbers on this map have changed a bit in that China is closer to the equivalent than all the states on this map. But the basic point is still the same and that is when you just start talking about a handful of states, four states in the west, a handful of states in the northeast, you're talking about emissions equivalent to those terms major admitting economy around the world. So working together or individually, states can make a significant dent introducing absolute emissions.

So you heard from Josh last year, I believe he talked briefly about the regional greenhouse gas initiative and I'll just give a quick update on what's happening with that. Just as a quick refresher, RGGI as it is affectionately known is the first mandatory US greenhouse gas cap and trade program, first program of its kind in the US. Its goal is to stabilize power plants CO_2 emission. The current levels between 2009 and 2015 and then reduce those emissions 10 percent below current levels by 2019. So when it first started RGGI had just seven states signed on and just within 2007 that number has gone to 10 as MA, RI, MD have all joined which means that RGGI, if you think back to the math I just showed, now that those states involved admit 10 percent of total US emissions and are equivalent to the 8th largest emitter in the world Canada. At the moment RGGI is still in the implementation stage, it is not really going to get up and running until 2009. At the moment individual states are adopting RGGI's model rule which is kind of a blue print for how RGGI is going to work and individual states have to adopt it through (inaudible) or regulation. States are also working on allowance option design. How they are going to distribute the emissions allowances under the cap and trade program. There are of course two broad categories of doing that, you can give away allowances for free based on some metric or you can

auction them off and emitters have to pay for them up front. And you can auction some of your allowances, you can give some of them away for free, you can mix and match and do a bit of both. What is interesting is that many of the states are committing to or seriously considering 100 percent auction of their allowances which is a pretty significant change from where things were about a year ago. Massachusetts actually just released its draft auction rule which was set up a 100 percent of the auctioning of allowances. RGGI is also close implementing their regional organization which will oversee and coordinate a program working on leakage issues and being able to attract imported electricity. Leakage is an issue whenever you have a group of states adopting regulations, especially in this case, rules and regulations of greenhouse gas emission as it is possible that those emissions will simply get pushed out of the capped region states may end up importing electricity produced outside of their borders that have high greenhouse gas emissions associated with its production.

Mr. Profeta: They're working on a system that will track the leakage at this point not a system that will actually have any program to control the leakage is that right?

Mr. Hogan: Exactly. So you also may recall that last year Josh talked about California's action especially the passage of 8032 A Global Warming Solutions Act of 2006 which set the first binding economy by targeting as many states and will hopefully get California to 1998 emissions level by 2020. Probably they are still thinking about how they are actually going to do this, it's great to set a target but then as you all know it's very difficult to figure out the way to meet it. One thing that is going to set with me is the release of California Market Advisory Committee report earlier this year. The committee was formed after a clash with the governor - 8032 authorizes the use of market mechanisms such as cap and trade and the committee's objective was to come up with what that system might look like and make recommendations for its design. And while it is likely that a market will be adopted in California, it is not a sure thing but either way this is a very comprehensive piece of work and it is well worth looking at. Also another major development in California just from January was the announcement of the nation's first low carbon fuel scanner in the state which aims to reduce the carbon intensity of vehicle fuel sold in California 10 percent by 2020. It's worth noting that when the state carbon intensity that means this reduction applies across the life cycle basis – so it's not just looking at tailpipe emissions, it's the wheel to wheel emissions associated with a gallon of fuel. So it takes into account emissions from transportation of fuels, from refining it and the whole production process. So it actually allows a fair amount of flexibility and how fuel distributors meet this requirement. You may have also heard in the news relating to California's proposed vehicle standards for greenhouse gases because it is becoming a pretty hot button issue, both at the state level and at the federal level. So if implemented California's proposed standard would mean that in 2012 new cars would have to emit 22 percent fewer greenhouse gases by 2016 cars still in the state would have to emit 30 percent less. I guess it's worth giving a

quick bit of history here, so under the federal cleaner act, California has unique authority to set emissions standards for vehicles in the fair air quality standards because California actually started regulating those things prior to federal government. So California can set a substandard and then it is really a formality but they have to submit a waiver to the federal EPA – federal EPA has to grant waivers California can go the same way. Other states can choose to follow either of the two standards, it can follow California or it can follow the federal standards. What's happened is that California proposed these standards several years ago and applied for the waiver from the EPA, the EPA has yet to grant it. But is has been a long on going process and in fact California announced earlier this year that if the EPA doesn't hurry up and say yes or no, they are going to sue them and I think it was actually just a story yesterday saying that the case will be filed next week. So that is setting up a bit of a show down again between the state and the federal EPA. This is significant because if the standards are implemented, 14 other states in addition to California will adopt them. Just this year Maryland, Florida and New Mexico all announced their intentions to do so - which would mean that the standards apply to, I think almost half the new car market in the US which is a lot of cars. And of course, the auto manufacturers are not too thrilled about this so they have filed law suits in California as well as in Vermont. The Vermont case was actually just settled against the auto manufacturers, the judge basically said states can do this and the auto makers would have to be innovative. Of course that's in appeal but it could have significant consequences for others in the law suit in California and elsewhere.

This is just a map illustrating all the states that have indicated they will adopt the standards if they (inaudible). Probably the other major collaborative effort that has emerged in the past year at the state level is the western climate initiative. Which was formed in February 2007 by five states and it since grew to include six states including Utah and two Canadian provinces so it is actually an international effort now. There are several observer states participating in the process who may opt in at some point and at this point even without counting the Canadian participants, these states are responsible for over 12 percent US emissions and are comparable to Germany which is the seventh largest emitting nation in the world. What these states are trying to do is similar to what the RGGI states are doing but a bit more ambitious. They are aiming to set up a regional target and then some sort of economy wide regional cap and trade system to help meet it. And that target was just announced in August they want to hit 15 percent below 2005 level by 2020 and the next step hopefully within the next year is to devise and implement the system that will allow them to meet that.

I am sure you have also heard about a major development in Florida just this past summer when Governor Charlie Crisp signed three climate related executive orders. I am not going to go through every thing here basically we go everything including the kitchen sink related to climate change but the order set statewide targets creating governor's advisory team to come up with a strategy for meeting these targets, adopt California's vehicle standard creates building

efficiency code including a host of other measures. So it is definitely a significant turning point not just in Florida but also the southeast. So this is by no means exhaustive but this just gives a quick run down of some other major events from the past year including NC's adoption of their renewable energy standard. NC actually has the distinction of being the 25th state to adopt this standard so the official half way point happened right here. In the past year eight states have established legislative climate commissions or executive advisory groups. A number of other states have either joined regional initiatives that target or adopted a number of other policy measures. You may remember seeing about summer of last year but it changed quite a bit. This shows all the states that have adopted targets and in many cases what's shown here for the most part are just near to mid term targets but all these states have long term projects as well. At this point there are 17 states that have adopted greenhouse gas emissions targets and seven of those targets were set just since last October. This gives you an idea of how quickly things are accelerating especially at the state level.

Question: Are those a combination of voluntary and mandatory targets?

Mr. Hogan: It's a combination of targets set for executive order and targets set through legislation. It's not necessarily clear that one is more binding than the other and the main thing with these targets is that its showing a commitment to leadership and that this is a curious issue for these states and they are committed to addressing it. I guess one thing I can say that is significant is that, I said that seven states adopted targets within the last year and all but two of those were set through legislation. So until this past year, historically most of the states have been setting targets through governor's action – executive order. But now that is changing, more and more legislatures are getting on board and really seeing this initiative tackle we are seeing more and more that bills are being enacted to set state wide targets.

This shows the 26 states plus the District of Columbia that's adopted renewable energy mandates. Illinois is the most recent, NC was just before that. So it is pretty amazing that there are now over half the states – well over half the population – has the renewable energy mandates of some sort. And of course they range across a large degree in terms of ambition in large part that is due to the resources available to an individual state. So some targets are pretty ambitious, 25 percent by 2025 and others more moderate but none the less it's a pretty interesting map to look at potentially given the debate on the hill in DC about a proposed RPS for in entire nation.

I am not going to go through all these in great detail but this just shows some of the collaborative effort that states are participating in. You can see the western climate initiative in the west, northeastern states participating in RGGI, many of these other efforts such as the Western Governor's Association are not looking at climate change directly necessarily but are looking at definitely related issues especially energy production. I guess one such major collaborative effort among

at this point almost 40 states is the climate registry. So this is an effort to develop a common system for reporting, tracking and verifying greenhouse gas emissions and greenhouse gas emissions reduction. The platform that these states are working to develop would be (inaudible) to voluntary programs or mandatory programs but really could lay the foundation for impending federal policy because before you can reduce greenhouse gas emissions you have to be able to track them and verify where they are coming from and where they are being reduced. This is just a quick update all the states adopting climate action plans – at this point there are 36 that either have completed plans or plan in progress. I am not going to talk a lot about local initiatives, of course local initiatives matter and there's been a lot of action at the municipal and city level across the country this year. One pretty significant effort is being spear headed by the Clemson Climate Initiative. This initiative was launched about a year ago in August 2006 and aims to mobilize action in large cities around the globe by helping these cities pull their purchasing power to reduce their cost of energy, their energy use and to become more efficient. This really cumulated in the energy efficiency building retrofit program which is a collaboration between the Clemson initiative, several major global banks and energy service companies and 16 the of world's largest cities including here in the state, Chicago and New York. In these cities these partners are all going to work together to reduce energy use in municipal buildings and find ways to make these buildings much more efficient.

The last of the conclusion and then hopefully we will have time for any further questions you may have. At this point much of the world recognizes the need for serious action on climate and everybody is starting to look ahead to and think about what a post 2012 international agreement might look like. And while it is true that for a number of reasons momentum is really picking up at the federal level. It is also true that the states are way out in front of this issue and are continuing to lead on climate and are probably going to do so for a while to come. States are achieving significant in the real emission reductions while simultaneously providing models and lessons for possible federal action. And even with the feds stepping up and doing their part some national efforts of the state level are likely to continue playing a significant and key role. It really doesn't matter what happens in places like NC and other states for these reasons and others. That is it so anyone have any questions I am happy to take them.

Mr. Garrou: Questions for Mr. Hogan? Thank you.

Senator Pittenger: Mr. Hogan I appreciate your presentation. Like to ask you about the relationship to China – it seems to me that your graph did indicate that maybe the eastern part of the country was a matter of emissions but now you said verbally that it's the whole country in reality. I think I would beg to differ with you on the role of China and the perception that what we are doing related to cumulative transcends or supersedes annual impacts – I think it's flawed. China

to my understanding is launching a new coal fired power plant about every nine days and has about 550 of them. I think that becomes a serious consideration if we're going to look at regulations and mandates and standards and caps in our state and around the country. Doesn't that seem irrelevant to you?

Mr. Hogan: While we absolutely think that we need to get China and India and other developing giants on board somehow, but it's important to keep in perspective where they're coming from and its unlikely if not impossible that China will adopt any sort of mandatory curve especially without the US showing leadership on this issue. We're hoping that China will bring us some sort of commitment whether or not it is absolute emissions reduction it might be a commitment to efficiency, waste reduced energy use. Due primarily to its Kyoto contribution many countries do look to the US as a leader in this issue and say that before we're on board you have to prove your commitment as well.

Senator Pittenger: I would just say in perspective, it seems to me that the US by nature of its own expression of the various states and members of congress, even the Democratic leadership that you outlined today from what I've read their contact with the Chinese, the Chinese seem to be not moved and really under-strained in their interest to pursue their economic development. These would be the use of these coal fired power plants.

Mr. Hogan: Of course the problem is this is the quintessential collective action problem. But really up until now the US and China especially has been using inaction on the part of each other as an excuse for doing nothing which benefits no one in the long run. So it is much more likely that China will come in the negotiation and think seriously about taking action, and they know this is a problem. In China they read the same scientific reports that we do, many of their cities will be especially vulnerable to potential impacts of climate change. So they know they can't afford to ignore them. But it is unlikely that they will seriously sit down and negotiate until they know that the US is a firm commitment to addressing their own emissions.

Ms. Choi: Follow up question on that. I think I read a report earlier this year Carnegie Mellon did on climate emissions and really how much that growth is driven by the US markets. It is almost likely its already occurring where goods and services are being made in China for the US market. Do you have any thoughts on how to deal with that trend? You've seen some of those proposals at the federal level on using trade rules and laws to try and address the situation, has PEW done any work on that?

Mr. Hogan: I am not sure that our international folks have addressed that specifically. But that is absolutely right a lot of products produced in China and the emissions associated with those products are parts that are being sold over here in the states. It's really statewide demanded at least in part, driving this rapid development overseas.

Mr. Profeta: If I could just speak – I was actually looking to testify in the Senate on that issue in July and we in our website have done, had our best trained lawyers do logical look at these questions and I think there are options. Both the bills in the Senate debate right now from Bingaman and Lieberman contain the same provision which I would just characterize ask for (inaudible) pack to be negotiated but if its within five years with no pack you begin to incorporate the price of the carbon into the imports into the US from China and other uncapped countries. I would say it is a grey area of international law. We will not know until it's litigated but in the last five years the trends (inaudible) are that environmental protection through such measures are more and more permissible. I invite you to look at that report on our website that talks about the fine points of legality.

Representative Harrison: Thank you Mr. Chair and than you Mr. Hogan for your presentation. I want to follow up on the (inaudible) bill emissions case you're discussing and we've been struggling with that issue here in NC and from what I understand about 30 percent of greenhouse gas emissions come from metal sources or at least in NC maybe approximately. These states that have adopted the California standards are waiting to implement until we get the resolution on the (inaudible) standards and did the Vermont court resolve the (inaudible) standard or was that just a separate issue that Vermont implemented the California standards?

Mr. Hogan: That's a good question – there are really two (inaudible) that have to be overcome. One is getting a waiver from the federal EPA and that process is dragging on and now looks like California is going to take them to court for failing to grant the waiver. And the other is litigation on the part of the auto makers. There are at least two such cases, there's the Vermont case filed in Vermont by auto companies and then there is another case in California. The Vermont victory in favor of the states, the case has been appealed so it is still going to be tied up for a while. But if that's upheld then it's likely that the California or at least possible that the California law suit will be tossed out. They are very similar and so the judge in California might look at the previous ruling and say this has basically already been decided. It's likely that that process is going to go on for a while. At this point, the standard is supposed to kick in starting in 2009 which is coming up pretty soon. It may be that they end up being implemented but that the deadline for them will (inaudible).

Dr. Smith: Thank you. Appreciate your presentation – since we have met last and you emphasized this but I just want to reiterate it. SC has established their commission and it is moving forward. I am involved with that and its been very positive but the biggest development is in Florida and just absolutely (inaudible) to that state into a leadership position with Republican Governor Charlie Crisp taking that lead and I think some very innovative things. And they now have a similar body to our climate action team that is meeting regularly and meeting their

first deadline of November 1st and we're tracking that very closely and being. involved with a number of folks down there. These are all very positive developments for the south and I think they should hopefully lift NC's spirits to the leadership that the state has provided and that we will need to continue to find leadership. One point that you brought up about the federal, I think we actually have a tremendous resource because I know that Tim and the folks at Duke have been very involved with the Lieberman/Warner bill. One aspect of that which I think everybody needs to pay very close attention to is this whole question about allocations and how they are going. The allocations are not, I would predict, going to be dealt with as they were dealt with under acid rain cap and trade, there is actually going to be a much more sophisticated regime of how to deal with it. Some of us are advocating for 100 percent option but there are various allocations that are being done and looked at and I think that debate is very well bused right now. But in our deliberations, I think one thing we should pay very, very close attention to is that there are provisions and I would like to ask Tim maybe to share with the group for states who do certain things to get these allocations. These allocations are worth serious money because the overall allocation budget may see a hundred billion dollars annually. How states receive allocations for taking early action, what is being proposed in this bill and what will be further debated in the coming months, I think is something that we need to pay very close attention to because it may help advise us on some things we want to do. Tim I was wondering if you might just share some insight that you've developed if you have a moment. I think it would be very helpful and its relevant to this particular topic.

Mr. Toben: I'm just lucky that I brought the bill with me. Does everybody understand what the allocation pool is when you create a cap and trade program on greenhouse gases you create emission allowances that you have to hold one to (inaudible) greenhouse gases? You will have to give those in SC and Georgia – well you don't have to give them (inaudible) but they should be given generous allocations. There still is some that get allocated to other people who can sell them and derive value from them. If they worth what they're worth to you right now, they're worth about $30 a ton and they can create six billion tons in the US program – that about $180 billion dollars worth of value. There is a program here overall that gives about nine percent of those credits to the state, they reward states that have taken action on the coupling, I'm making sure that the POC are adjusted to award on efficiency and that they reward states that have taken energy efficiency building standards and they reward states for taking early action in terms of creating a cap on their own emissions. The contingents are allowed at least five percent of that pool is given to the coupling efficiency investment states and two percent of the pool is given to states that are taking early action in terms of capping their own emissions. There is also another pool that goes to states generally just to have resources to adjust in the climate change. Its this one bill that most likely to move to the floor – it's an early draft though but I think the overall message is that the federal legislation is looking at states that are taking early action moving and trying to award their actions.

Mr. Garrou: Would these allocations go to the state government?

Mr. Toben: This pool would go to the government itself for their own usage and there is a long laundry list that they can use them for.

Mr. Garrou: Welcomed Representative Harrison as Co-Chair and looks forward to working with her. I would also like to apologize for being late, a big accident on 40. Now we will hear from George who will tell us about the REPS that was passed in the Legislature last session.

George Givens: As I indicated in the beginning, many of you are familiar with this and if you've already heard all you want to hear about this bill, (Exhibit E) I will not be offended if you take a little break and I'll try to keep it as entertaining as I can. You have three documents that are coming around in connection with this presentation, a copy of the bill itself in its ratified form and signed by the Governor that's Session Law 2007 397. There is also a summary (Exhibit F) which I will be using as my guide through this and a copy of the fiscal note (Exhibit G). Now the bill in its entirety is a complex bill that deals with a number of different areas. This bill by the way was sponsored by Senator Albertson, it was one the earliest bill that was introduced which is why it is numbered Senate Bill 3. There are different ways to characterize the contents of this bill, I tend to think of this bill as having five parts – it has the renewable energy and energy efficiency portfolio standard and that's where I will be spending most of my time. It also has provisions related to man size management, it has provisions related to recovery of additional cost under the annual fuel adjustment clause, it has provisions related to construction cost of base load generation, I'll be talking about that only in most general terms and then it has some tax relief provisions related to the phase out of sale taxes paid by farmers and manufacturers for electricity, pipe and natural gas and other fuels and renewable energy credits. There is also a provision in here that adjusts the public utility and electric membership cooperatives, regulatory fees, that was done both in this bill and in the budget bill so it is not an essential part of this bill.

This bill and its House companion, not identical companion, but its kindred bill in the House introduced by Representative Harrison, House Bill 77 started out as energy efficiency bills with emphasis on renewable energy portfolio standards. The background of that involves this Commission and Environmental Review Commission and goes like this. There was a proposed study in the Studies Act of 2005 a studies bill that required a study by the Utilities Commission of the feasibility of these renewable energy portfolio standards. The Studies Bill in 2005 failed of enactment – that happens with increasing regularity around here. The Studies Bill of 2007 also failed of enactment but studies will never the less be ongoing. As a result of that the Environmental Review Commission consulted with the Utilities Commission about the possibility of conducting the study. The Utilities Commission was able to accommodate that request and fund the study

about three hundred thousand dollars more or less, something in that range. It seemed advisable to increase the quality of the study and basically the buying, people who would be affected to establish an advisory committee and the Utilities Commission did that. That resulted in the preparation of a (inaudible) proposals and ultimately the Capper Associates was selected as the contractor to conduct the study. Lacapper subcontracted with GDS Associates for a study of energy efficiency as a component of the renewable portfolio standard and these reports are reports that you've seen, I think we had presentations on them and distributed them to you last year or early this year. As I said they lead to the drafting of Senate Bill 3 and House Bill 77. Senate Bill 3 was then the subject of a large stake holder process, we met either in this room or downstairs in 544 averaging 75/80 participants a meeting and we met for several months hammering out the details and adding portions to the bill to make it acceptable to various interest groups.

Turning to the renewable energy portfolio standard, first of all, it would be useful I think to talk about what is a renewable energy resource. These are defined in the bill and there is a list and I'll comment on some of these. Renewable energy resources include solar electric, or solar thermal energy, wind which we have an abundance in this state in the mountain region and the coast and then we also have an abundance of legal and political restrictions on the use of wind. Hydro-power – many people have the idea that hydropower is a much large share of the generation mix now than it really is. Hydropower is used primarily to meet peak load in demand and by most accounts all of the available hydropower resources in this state have pretty much been dealt out because of flooding large new areas of land which displaced so many people and so many other resources. Renewable energy resource also includes geo-thermal, we don't have too much of that in this state, perhaps none, ocean current or wave energy, we have a long coast, we don't have particularly high tides variation here and of course the coast are committed to other resource uses. We have biomass resources and sometimes we refer to as the Saudi Arabia of biomass and so this bill gives particular attention to biomass resources. It's an interesting list of things that's included in the definition of biomass resource, including agricultural waste, animal waste, wood waste, (inaudible) combustible residues, combustible liquid resource, combustible gas, energy crops and landfill methane. Also included in the definition of renewable energy resource are waste heat and hydrogen. Specifically excluded from the definition is peat, fossil fuels which we are told are gas and nuclear energy. So what does this bill do or what do you say about the use of those. It says that electric public utilities must achieve a generation mix that includes 12½ percent renewal resources on a phased in schedule that starts at three percent by 2012 and caps out at 12½ percent by 2021. That 12½ percent is made up basically speaking of 7½ percent renewable resources in and another 5 percent that will be derived from energy efficiency.

The LaCapper recommendation was a 10 percent renewable standard. There were folks that wanted that number to be higher, and that was the subject of a

great deal of debate. The LaCapper study on which we relied indicated that the 10 percent would be doable without undue economic dislocation, in other words without excessive cost. We did feel that based on the GDS report that there was room for an additional two and one half percent to add on to the energy efficiency component. One of the important features of this bill is that it includes everybody we didn't leave anyone out. Early in this process the electric membership cooperative and particularly the Electricities, the municipal electric power suppliers asked to be left out and they (inaudible) through the negotiation process able to stay in – they have a less aggressive schedule, their requirement caps out at 10 percent in 2018. All of our major suppliers of electricity are included. Electric public utilities which includes the investor owned utilities, we have three in this state, Duke, Progress and Dominion and the (inaudible) in the co-ops can basically meet the REPS requirements by generating electric power at new renewable energy facilities. This bill is focused on bringing new facilities on line and there are a couple exceptions to that. We made the exception for existing poultry waste and we made an exception for existing small hydros to encourage their continued use.

Another way this requirement can be met is through the use of renewable energy resource to generate electric power at a generating facility, reduce energy consumption through the implementation energy efficient measures, purchase of electric power from renew and renewable energy facility, purchase of renewable energy certificates derived from instate or out of state sources. The purchase of certificates has captured 25 percent, there is a lot of back and forth about what would or would not be constitutional under interstate commerce considerations. Most states that have adopted an REPS have included a limitation on out of state sources in order to encourage instate development and certainly those requirements are constitutional until challenged and found not to be constitutional. And we believe that because they are not enacted for economic reasons primarily but for public health and safety reasons that they would probably be sustained. We have that schedule of implementation. We have some speakers set aside for solar, for swine waste and for poultry waste. These are covered in your summary but for solar and swine waste it is two-tenths of one percent on a schedule that would cap out at 2018 and then for poultry waste it's expressed not in percentage but in terms of mega watt hours and it caps out at nine hundred thousand mega watt hours in the year 2014. So these particular set aside and there has been some discussion about those for replacing the bill in recognition of particular interest and goals and values including the environmental value of dealing with swine and poultry waste on the one hand and the desirability of encouraging solar which is probably at this point the most expensive of the renewable sources. So they represent a negotiated agreement among interested parties that reflect those values.

The bill does require that biomass combustion processes for new renewable energy facilities that deliver (inaudible) would have to reduce emissions of air pollutants to degree that it is achievable for the facility taking into account the

environmental and economic impact. There is concern about the emissions from biomass facilities, there is that provision in the bill and the value of the use of biomass depends upon what you compare it with. If you compare biomass to the most pristine source that might be available, then it perhaps compares unfavorably but if you compare it to the sources we actually have it appears to be as environmentally advantageous. The bill provides that the cost of these renewables will be recoverable by the utility through an annual rider approved by the Utilities Commission. And that rider is capped to prevent what is called rate shot. The schedule of caps is in your summary for residential customers in the period of 2008-2011 is capped at $10 per customer account per year, in other words, less than $1, it maxes out at $34 per year or a little less than $3 per month in 2015 and thereafter as a separate schedule for commercial accounts and industrial accounts.

The Utilities Commission is charged with rule making to implement the REPS, that process is underway – there is among the many instructions to the Utilities Commission a provision that provides for what is called an off ramp that authorizes the Utilities Commission to modify or delay the requirements if it determines that it is in the public interest to do so. Other noteworthy provisions that the rule making that the Utilities Commission has directed to address is to establish interconnection standards for renewable energy facilities, to re-examine the net metering issue and to ensure that renewable energy facilities that deliver power will be in substantial compliance with all federal and state laws regulations, etc for the protection of the environment and conservation and natural resources. There is also extensive reporting and analyses requirements, this is covered at the bottom of page 5 of the summary and I will not go into too great a detail about that.

Senator Clodfelter and his floor debate on this bill characterized the demand side management provision as one of the most important sleeper provisions. The demand side management is distinguished from energy efficiency in this way – energy efficiency is the process by which you get the same amount of work for less energy input. Energy efficiency occurs when you replace a 100 watt incandescent light bulb with a fluorescent light bulb that produces the equivalent amount of light but requires substantially less electricity perhaps on the order of 13 watts instead of 100 watts. The demand side management on the other hand doesn't necessarily involve any reduction in the amount of energy required to perform a task but shifts it from one time period to the other to reduce the total peak demand at any one time on the system. In general the electric providers have to meet the requirement for the last kilowatt when someone flips the switch to turn on the lights on the hottest day in August and that last kilowatt of demand is typically the most expensive so it is expedient to shift demand where possible to other time periods where demand is less. This bill provides for recovery of cost of demand side management programs through an annual rider.

There are several sections here dealing with cost recovery – there are adjustments to annual fuel cost and perhaps it would be useful to take just a moment to talk about the way electric utility rates are established. In general there are rates established by the Utilities Commission that reflect the rate base, that's the capital investment that the utility has, and reflect a return investment against that rate base and what the rates should be are determined periodically by the Utilities Commission through what is called a general rate case, which is a proceeding that's conducted for particularly utilities we just finished one for Duke that resulted in significant adjustments.

The other component of the bill is the fuel adjustment clause – this occurs outside the general rate case and reflects the cost to the utility of fuel and allows the utility to recover the fluctuating cost which can go up or down over time of the fuel component. Senate Bill 3 expands the use of the fuel clause to provide for the recovery of costs other than fuel in particular for the cost of what are called reagents that is the chemicals necessary to make the scrubbers work. The scrubbers that in particular are required by the Clean Smokestacks Act, such reagents are among the line of limestone and so forth. There are a number of other costs that will be recoverable under the fuel adjustment charge that is being renamed as fuel and fuel related charges. You can see those at the bottom of page 6 over to page 7 of your summary.

The other component of the bill that relates to the allocation of cost has to do with allocation of cost to finance base load generation. In general base load generation is paid for under existing law in this manner. A utility that proposes to build a new coal or nuclear plant goes to Commission and gets what's called a certificate of public convenience and necessity that authorizes the construction of the plant. The utility is then responsible for going out and designing and building the plant and for financing the plant through the usual financing mechanisms. The utility does not get to recover any of its costs until the facility is determined by the Utilities Commission to be used and useful. In other words, it's placed in the service at which point cost that approved and reasonably incurred goes into what is called a rate base that is the total capital investment upon which rates are calculated. The only exception to that mechanism is what happens if the costs are so excessive that the utility experiences financial distress in which case there is a possibility for inclusions of cost before the seller actually goes on line. The problem with that mechanism is the financial distress standard means that the interest rates are likely to be higher, almost certainly be higher if the utility has to resort to that. On the other hand if they don't go into financial distress then they are faced with the long term caring cost from start to finish of the project. Those interest costs then become a significant factor that would have to be added to the rate base all at once when the plan actually comes on line increasing potential for what we locally refer to as rate shock or sticker shock when the adjusted bills come in.

What this bill provides for is a mechanism of ongoing review under which once the certificate of public convenience and necessity is obtained and construction begins and costs can be evaluated by the Utilities Commission on an ongoing review basis and those costs can be determined to be reasonable and prudently incurred if they are at that time instead of waiting for the end of the process. That also allows for the possibility of what is called construction work in progress or whip as it is often referred to inclusion of construction costs in the rate base before the plant comes on line. There are all sorts of variations that have to be considered including cancellation of the plant, that's all included in your summary I'm not going to go into that in great detail. I would just observe as follows: the effect of this in the eyes of some folks is to make construction of coal or nuclear plants easier. It does do so in the sense that it makes it less expensive, it is not a weight lifting contest so it is not a matter of easiness it is just a matter of cost. Whether or not those plants will in fact be constructed will be debated in various forms including if the Utilities Commission in the certificate of necessity process opposes it. This bill does not prejudge that except to provide for what is hoped would be the least cost financing mechanism for rate payers should those facilities be required.

We have not opened a new base load plant in this state since Sharon Harris went on line in the late 80's. Given the projected population and economic growth it appears likely that new base load generation will be needed even if there is not economic development and no increase in population the existing facilities in some cases are getting quite old and it is probably desirable to build new facilities that would be cleaner and more efficient than some of the existing facilities that we have. There is of course the hope and the goal of this bill that traditional base load generations may not be necessary if renewables are demonstrated to be able to meet the demand and the only way to determine that is to start the process of bringing them on line which will take up back to the original goals of the bill.

The other provisions of this bill have to do with tax relief there is a phase out of the sales tax paid by farmers and manufacturers for electricity, pipe and natural gas and other fuels. That phase out occurs in 2010 and then there is a provision that establishes renewable energy tax credits for nonprofits. That's a matter of primary tax law and it's explained in your summary on page 10. The bill also contains a severability clause. One other feature of the bill is that there is a provision of the bill that deals with the possibility of a federal energy bill on the same subject. The state law says that unless the federal legislation, whenever it is enacted, pre-empts the state law that the Utilities Commission will be charged to determine which provisions are the more progressive or more stringent and implement the better provisions of state law and federal law. It remains to be seen whether there will be a federal pre-emption because of NC's actions and the action in IL, I believe this summer there are now a majority of states in the nation that have a REPS so it seems to be probably relatively unlikely that the

Congress would pre-empt all the federal action that is occurring. That remains to be seen. That's the summary and I'll do my best to answer any questions.

Senator Albertson: Thank you Mr. Chairman. Just a comment and I guess everybody can understand now why all the members of the body up here love and appreciate George. You just heard a good analysis of this bill. George you always amaze me. Thank you.

Mr. Garrou: (Can't hear anything)

Mr. Profeta: (Inaudible) provision on this issue, provisions I've talked about on allocation to the state. The pre-empt question will probably be in the federal RPS debate that's currently in conference.

Mr. Garrou: (Inaudible can't hear)

Mr. Profeta: Not (inaudible) in the record.

Representative Harrison: Actually I talked to a member of Congress staffer yesterday and he said it does not at this point.

Mr. Urlaub: Thank you Mr. Chair. I was wondering if I could ask a clarifying question of Mr. Profeta about a comment he made earlier relative to Mr. Givens' presentation. Did you mention earlier that one of the items in proposed climate legislation is that states that has decoupled their rates and could get some type of preferential allocation of carbon credits?

Mr. Profeta: Yes.

Mr. Urlaub: Because I noticed here in the summary as well of Senate Bill 3 our state Utilities Commission is asked to no later than September 1, 2008 to prepare and submit an analysis of whether rates structures, policies and measures including decoupling and place in other states should be implemented in NC.

Mr. Profeta: I would just like to clarify – there are three main proposals that you have to consider in terms of what is going to happen in federal legislation. There is the Lieberman-Warner proposal that come of out the Senate Environment Committee that will be the vehicle to the floor. There is Senator Bingaman proposal from the Energy Committee that will meet it on the floor and will have to resolve their differences and then the House Representatives (inaudible) and (inaudible) are writing their own bill on cap and trade. The Lieberman-Warner bill contains this provision on the states and it is the vehicle for the Senate right now. The Bingaman I believe has not (inaudible) nothing explicit on these issues and the Dingle bill is still a glimmer in Dingle's eyes and no one knows what it says.

Mr. Garrou: (Inaudible).

Mr. Givens: Mr. Peterson has arrived and if you're ready to go I think we will stick with the order.

Mr. Brock Nicholson: Thank you Mr. Chair. I will lead off with a few comments and then turn it over to Tom Peterson with the Center for Climate Strategies who will run through the real heart and meat of the CAPAG work. First of all a few comments here, Secretary Ross does send his regards he was here for a short while but was unable to stay but he again appreciates the work of this body and the CAPAG. I particularly want to thank those members of this body who are also very active both as work group members and as members of the CAPAG also I believe there were nine sort of joint members that has been working on both efforts certainly. As you recall, our last meeting was the 22nd of February and since then we have had actually three more CAPAG meetings. At that meeting we presented to you the first 16 recommendations which were unanimous recommendations from the CAPAG to this body and then in May and then again in June we had entertained the balance of what now is 56 measures. We often refer to 53 but we kind of sliced and diced then and we are now up to 56. We did have a meeting just last week to start the process of reviewing the report, the last decisional meeting was in fact in July and this meeting last week we are starting to meet with the CAPAG members on our report. I believe being passed around is a piece that we handed out at that meeting of the preference executive summary in Chapter 1 and Tom will refer to some of the graphics in that piece when he discusses the real heart of it. It's the piece with the globe on the front, (Exhibit I) small piece there. I will point out that this part of it and the balance of the report which is rather voluminous is on the website and available. We do have very limited number of copies available so if you would like a paper copy we have a couple of those remaining that we might be able to get you one. So if you are interested, just let us know.

One of the significant things that we will talk about and Tom will talk about specifically is great economic opportunities that many of these measures offer and that they are in fact called savings net of cost. On the advice that we got last week which is important, we will emphasize in the final report, if that is in order to realize these benefits, these savings one needs to spend money up front of course and we will provide some more emphases on that part and more information on that. You will not necessarily see that in the copy you have today because that is in fact the same copy you had last week. It is a draft copy it is not a final by any means nor is the body of the report either. I think to sort of set the stage here a little bit I want to emphasize a couple of things that we have put in the preface of this report and you should have a copy I believe inside your cover there. I'll just read a portion of this: This report contains recommendations from a voluntary stake holder advisory group on potential measures and I'll kind of back up and emphasize voluntary and again emphasize that these members put a lot of time in and a lot of effort on this and in these eight meetings and in excess I think by now that at least 80 phone calls and or meetings relative to

work groups. It was quite an investment and we really do appreciate that. This advisory group came up with these recommendations of potential measures to reduce greenhouse gas emissions that are worthy of consideration by policy makers in NC. And that is part of the process we are here today about is to show you what has been done and of course the final report with its revisions will be the actual instrument that will present those to you. The Climate Action Plan Advisory Group consisted of more than 40 volunteers from business, industry, environmental groups, academia, government and the general public. The consultant Center for Climate Strategies, CCS provided facilitation and technical analyses expertise from over 300 potential mitigation options, more than 50 were analyzed considering likely greenhouse gas reduction costs and benefits. This report is not intended to be a climate action implementation plan for NC. Such a plan will come only after state policy makers access these and other recommendations further. However the data, the results and the recommendations contained in this report provide valuable guidance for the creation of an action plan or plans for legislative, administrative, regulatory or voluntary action. I guess I wanted to site just a couple of examples, we've actually started down this road already and George summarized Senate Bill 3 which I guess is a grand example of one of the recommendations in concepts that we provided last February and that was for a REPS. The one that specifically the CAPAG was talking about was not recommended with a number in it per say but certainly the concept was recommended as were a number of other measures on energy efficiency that showed up and I believe it was Senate Bill 668 and a number of other bills which did succeed in the Legislature this last session. So I think in one sense our recommendations and recommendations of this voluntary group are showing up. Another item that I think we are very proud of and was touched on earlier a little bit in one of our crosscutting measures presented in February and that was that the state should join a multi-state registry effort. We went a step or two beyond that and we in essence joined a national one not just a multi-state one, the climate registry. In early February NC became active as one of the charter or steering committee states for development of this registry and we now serve not only as a member but on the executive committee of that registry and presently developing a general reporting protocol which will be out in about a couple of weeks for public comment. This will be in a sense the national standard for reporting into these be it business or industry, government, states, universities and so forth. This is a voluntary registry as Patrick indicated earlier but will be designed to facilitate those states that may want to have reporting by their entities to be mandatory. It's voluntary it will be third party verified so that the quality of the information in that registry, whether it's put in AZ or NC, WVA will be of the same quality. The other thing that NC is doing relative to one of the recommendations that was made to this body in February is that we have served notice on our large sources in NC that they will be reporting greenhouse gases starting in 2008 for the year 2008 as part of their normal inventory process.

The last thing I want to mention before Tom fills you in on the success of this group is a presentation you will hear from Appalachian State. You probably heard me over the course of the last year and a half - two years talk about the sense that we have that many of these measures have good economic value in their own right and that they have some jobs potential. We thought we had better have some work done to put some quantification on those assertions and so we did as an adjunct to the CAPAG work proper and we contracted with, actually CCS has as a subcontract to Appalachian State University to run some jobs analyses on the measures that are being recommended which you will get today following Tom's presentation is a look at the preliminary results and in earnest, Appalachian I want to say that this is excellent work, these are preliminary results. There is more work to do, you are free to ask questions certainly and any advice on how the implementation should be framed from this body I think would be very welcome. It is preliminary but I think it is perceptively very good news. I think with that Tom I will turn it over to you.

Tom Peterson: Thank you Brock. About what I would do is provide a summary in the form of a series of slides and tables of the work of the CAPAG and in order to bring the Commission up to date on the progress that it has made since your last review is work in progress earlier this year and then be happy to take questions whatever your directions are there.

First thing I would like to do is just (inaudible) excuse me, it is a obviously a thick document - the technical details are in the appendices and I'll share some of that information but I just wanted you to know that you can access this information directly in report that has been provided. The very first part of the process involved the development of a preliminary inventory and forecast of emissions in NC. The slide that is posted right now is the final version that went through the deliberations of the CAPAG and involved a number of suggested modifications to either the data sources methods or assumptions that were used on the initial draft of the inventory and forecast. It was finalized by the group to incorporate all suggested changes and you can see the results of it broken down by sector. The bottom line is an increase in emissions from 1990 to 2020- that's significant and this is certainly a recurring pattern that we see in all states in the US as a continued climate emission.

To summarize the final mitigation actions recommended by the Commission they are broken down in five areas that correspond to work groups that assisted in an advisory capacity to CAPAG in terms of understanding potential options for consideration. How they might be designed, how they can and should be analyzed, etc. and the total number is 56 depending on how you count some of the sub-options. You can see the break downs by individual sector but obviously this effort was comprehensive in terms of looking at all sectors and looking at all greenhouse gases within the sector so a comprehensive process. I just note that I believe it was the last time that this group got together it considered 16 of the options that the group had come to early consensus on that we will note a little bit

later on, and the remaining 40 since that last meeting have been fully developed and finalized by the CAPAG. So again the last time the Commission got together it was able to consider and endorse 16 early consensus items. There were a number of other options that were suggested by the Commission at that last meeting that were approved as well. At the end of the day, out of the 56 options 48 received what we call a unanimous consent which was no objections to final recommendation. Eight of them received what we term a super majority which was five or fewer objections. We also had a third category of consensus available which was simple majority but all of the recommendations either were unanimous consent or super majority. And just to remind the Commission we did use the formal procedure of voting by inviting objections. Where objections were identified asking for constructive alternatives that would address the various consensus allowing the group to work further to iron out potential conflicts and barriers to consensus and it was certainly successful in the vass majority of cases in terms of ironing out potential conflicts. Within the report for the eight recommended actions that received the super majority of support we do have a section which characterizes the barriers to consensus which is where you will find the rationale for the objections that were registered. But again they were at a relatively low level in terms of overall percentage.

This graph is a summary of two different assessments in an aggregate level that this group finalized. The blue line is the top line of the inventory and forecast that we saw just a couple of slides ago. This is the rate of emissions growth over time from 1990 to 2020. The green line is the level of reductions in year 2010, in 2020 an aggregate that are estimated from all 56 actions recommended by the CAPAG combined. So this is, if you will, the level of effort where achievability that is estimated from all actions together. And within the report you will find for each of the work groups in the summary chapter an explanation of how that green line was calculated because it is not a simple addition of all the actions. It takes into consideration overlapped and interactions between the recommended actions so that has been scrubbed out, if you will, and that green line is a line that is the result of the integration of all 56 actions combined. You can see that roughly the end point in 2020 of emissions were all 56 actions to be implemented and their potential for reductions realized would bring emissions back very close to 1990 levels.

This is, as you will see a little bit later, actually a relatively important index point - we see that many states and other jurisdictions are planning for both short and intermediate target years. The most common and intermediate target year is the year 2020 and it gives us a very strong basis for comparison between the efforts of different states and we now have the advantage of having bench mark for quite a few states that have undertaken comprehensive climate action plans. So we can compare the potential here in NC with others and it compares very favorably.

In the report is a lot of mass and accounting and one of the summary tables that you will find is the break down by each of the color coded sectors or work group areas and the result of quantification or the recommended actions in each of them. So we see in the first column the estimated greenhouse gas reduction potential for year 2010 and that's expressed in million metric tons carbon dioxide. The next column we see the estimated greenhouse gas production potential - a snap shot in year 2020. The third column which is total 2007 through 2020 is the cumulative greenhouse gas production potential for that particular sector for that set of 13 years. With each of the options one of the design decisions that the group made was when that option would start, when it would stop and so the timing of the option varied just based on the will of the group. But the earliest they start is 2007 some of them may start later than that because of various legs involving implementation.

The fourth column is the net present value of the direct cost or cost savings associated with the implementation of the actions if it were to be adopted and were to be implemented based on the decisions that the work group made in terms of design and implementation mechanisms and related assumptions. The final column is a ratio that shows us the cost per ton of carbon dioxide equivalent removed. This is an important metric in climate change mitigation the cost per ton per measures and you will see a graph in a minute that profiles each of the individual options on a cost per ton basis as well as a total tonnage reduction basis. So for most of the options the group requested quantification of the environmental benefit in terms of greenhouse gas production potential as well as the direct cost in terms of the cost per ton of greenhouse gas removed for that action. In some cases quantification was not requested, educational programs would be one example, but in most cases quantification was conducted.

At the bottom of this slide we have provided a call out of the cumulative greenhouse gas emissions that would be removed between now and 2020 were all 56 options to be implemented based on the analysis that the group agreed to. We also show the cumulative cost in this case, cost savings that would be associated with the full implementation of all the 56 actions. The number is a negative because the net which is a combination of positives and negatives shows unbalance, a savings would be associated with the implementation of these actions. The details of those savings are included in some detail in the appendices of the report for each and every option. Most of what is driving the cost savings figures is energy savings that are involved with the implementation of these actions.

Appalachian State University has been asked to take a look at potential economic benefits that go above and beyond the direct cost or cost savings associated with these actions. So they will specifically address the estimation of potential job impacts, personal income, and value added. But these numbers do not include any of those potential secondary economic benefits that they will cover later today.

This is also not inconsistent in terms of results with what we've seen in a number of other states and a number of other comprehensive climate planning processes in the last few years in terms of their being a significant finding of potential cost savings that is driven by the priorities that the CAPAG and other advisory groups placed on economic performance for their selection of options. So the group generally has wanted to find options that were high economic performers. Brock mentioned the list of 300 or so potential actions that were pulled together at the outset of the process based on actions already underway in other states as well as NC. The group added almost 60 new potential actions to that list and then went through a process of prioritizing and selecting actions for recommendations. And one of the criteria was greenhouse gas reduction potential but a second criteria that was very important was the cost or cost savings, obviously the group worked very hard to find options that performed well on both measures. The other two criteria that the group used were co-benefits and feasibility issues which played an important role.

Representative Harrison: Thank you on the net present value slide, did you say the figures there are primarily energy savings derived? Is there any factoring in there that cause the carbon emissions?

Mr. Peterson: Thank you for asking – this analysis does not modify the cost of emission in terms of their potential environmental impact. So it is not quote un-quote, a cost benefit analysis because the symmetries of that particularly mean monetization symmetrically above cost and benefit. In this case, this is a monetization of the actual cost of implementation and the environmental benefit as expressed in physical terms, the tons reduced.

I wanted to just give you a thumb nail here on the contents of the technical appendices of the report because they are the record of decision of the CAPAG in terms of actual recommendations and all of the related details. The majority of this report is in fact a technical appendix within each and every one of the 56 actions that were recommended by the CAPAG. There is a policy template we call it which is a mitigating template which is written up in whatever level of detail the CAPAG thought was necessary to capture the information that was needed to reach final agreement. Some are brief, others are long but in all cases they include a standard set of descriptors of that option that you can look at to identify the details that were behind the recommendation. It includes a description of the policy in what we hope is plain English, a description of the policy design which is the statement of the numerical goals timing in terms of target years for start and stop, a coverage of parties who actually have to implement the action and any other key features of what we call policy design. These were developed early in the process after the priorities for analysis were first developed because that is the set of parameters that we need in order to quantify both reduction potential and cost. That is the next section of the template which is the estimation of greenhouse gas reduction potential and cost or cost savings. I would like to call

to your attention very specifically in blue a set of key descriptors of that work which have been important, not only in the structuring of analyses but the development of consensus behind them. We do our best to break down analysis of the actions in terms of the data sources that were used, the methods used for analyzing data, key assumptions and key uncertainties, and we do this in order to try to provide as much transparency as possible in terms of how the numbers were developed. It is not unusual for the members of the CAPAG to want to see modifications of any one of these elements of analysis to determine what their level of sensitivity is and to bring in line the analyses with what they believe is the most realistic and appropriate approach. So a big part of this process was working for a long time with advice and assistance of the technical work groups and then decisions by the CAPAG to work on the analysis to bring it to a level that was acceptable for final decision making by the group. And you will see again quite a bit of background material in the current list of appendices there is actually another set of reference material that accompanies that that is posted on the web.

The other elements that are in the policy template for each and every one of the 56 actions that are important include a description of related policies and programs in place. All of these analyses are above and beyond business as usual so to the extent necessary. There is a notation of key business as usual policies and programs already in place to the extent that the group felt it was important. There is a notation of significant co-benefits, significant feasibility issues and for the eight actions that did not receive full consensus a description of specific barriers to consensus. We did our best to solicit feedback from the group on their specific rationale for those who did object in the eight cases where there were objections and have tried to reflect that as much as possible in a fact based format. Then finally there is a listing of the actual final levels support for the actions so I walked you through this just to help you crack the report and understand how to read through the technical appendices in each of the policy templates. Again the detail there is the reflection of the work the group felt was needed to reach final agreement.

This is a summary slide which is probably too small and other wise scripted to understand – it's contained in the final report. It is a lifting of many of the 56 recommended actions with their estimated greenhouse gas reductions and I suspect this is an accumulative number but this is a simple ranking of the scale of reductions associated with each of the individual actions. So certainly not all of these recommendations are created equal in terms of their potential to reduce emissions, we see a series of what we call big ticket items and then others that slope down but were considered none the less to be important by the group in terms of identifying a full level of effort and also bringing forward important co-benefits.

The next slide is the graphic portrayal of the cost per ton for most of the 56 actions recommended by the group. On the left you will see lines that go down

or bars that go down beneath zero. These are the actions that based on the analyses of the group would actually result in a net financial savings. It is important to underscore that the net calculation involves a combination of positive costs, cost outlays combined with cost savings. The timing may be different many of these involve an initial outlay in year 1 with savings in later years. The mathematics of the calculations for each of these are found in the technical appendices but you can see that a great many of these options result in net economic savings. I would also observe that this is a fairly consistent pattern that we see now not only in other state climate action plans but in independent research, McKenzie and Companies produced a supply very recently which is looking at very recent results of either negotiated agreements or actual implementation of greenhouse gas abatement measures. It is very clear in the literature and reflected in the work of this group that at least potentially there is a significant opportunity for economic savings for individual measures. On the right of course, we see measures that on the net resulted in a positive cost outlay. They are non the less important in terms of the achievement of the overall level of effort to reduce emissions in aggregate. I would observe here also that it is not uncommon for plans to be focused on the combination of all actions positives and negatives so that the combination taken together maximizes the economic performance rather than simply isolating measures one by one.

I have listed on the slides and the final recommendations by name for each of the actions. I will not go through them in detail now but we certainly can go through them in detail whenever if you would like. In blue I have highlighted actions that were approved by this group at its last meeting based on early consensus recommendations of the CAPAG. Quite a few in this cluster are residential-commercial-industrial; you will see that this category includes energy efficiency and conservation measures in particular. The second group that had only two early consensus items at the last meeting is the cluster we call energy supply which includes electricity and heat primarily. But this is what we call stationary source energy supply and activities that can shift to lower emitting technologies and practices.

The next cluster is transportation and land use – it turns out that I made an error when this group last got together and did not note that two of these actions actually had been identified as early consensus by the CAPAG so they were not reviewed and recommended for approval by this group, but these have all been completed since. Transportation and land use involves the combination of light duty and passenger vehicles as well as heavy duty vehicles. Freight for instance, and within the arena of passenger vehicles the three areas generically of focus are the reduction of the carbon content in fuels through renewable fuels etc. The reduction in transportation and travel demand through location efficiency and the improvement in vehicle technology or operations that reduce the carbon foot print of the actual operation of the vehicle. Those same categories apply to freight as well.

Agricultural forestry and waste included a series of potential action areas. None of these were available for consideration at the last meeting of the Commission but have since been completed and generically include a combination of bio-energy, energy recovery from waste, other forms of efficiency and waste, the conservation of forest and farmlands through protection and through improved conservation practices for working land and some technology improvement in the operation of the farms. The final set of recommendations are what we call cost-cutting issues, they generally pertain to more than one sector and include inventory forecast, reporting registry, a series of measurement approaches designed to support actions taken at the individual sector level as well as education and outreach. And then the whole arena of adaptation to climate change to the degree to which we have climate change inevitable, adaptation to it, and then, of course the consideration of the establishment of goals by the Commission. I would just note with respect to the goal issue, one of the more important pieces of information that was developed by the CAPAG just supports considerations by this group was the quantitative analyses of the emissions reduction potential of the actions taken into consideration, cost, co-benefits, feasibility issues. These were all approved at the last meeting of the Commission with the exception that the discussion of goals is on a continued basis.

I had mentioned earlier the consistency of outcome with the CAPAG process in other state climate planning action processes in the US. Last year we did a scale up analysis through my organization of the results of plans that were available and completed at that time. It is clearly out of date because a large number of states have undertaken and many have completed plans in this calendar year. But based on the scale up analysis of the actions taken by what we call leadership states, those that have developed climate action plans, we see a potential for reducing emissions to 1990 levels. The national growth rate and emissions from 1990 to 2020 is roughly 50 percent and the collective effort of these states were it to be scaled to all 50 states would reduce emissions to 1990 levels again with the same caveats that we discussed earlier in this presentation assuming all actions were fully implemented and the estimates were accurate in terms of their actual emissions potential. This is a very significant finding in that by coincidence this matches the level of effort that is identified in the interim year of 2020 by many federal bills under consideration in Congress and it is a bench mark in terms of early action that is consistent with long term climate stabilization goals that have been recommended by many members of the scientific community and are discussed in the intergovernmental panel on climate change for the assessment report National Academy of Sciences etc. So the level of effort from the actions identified through these processes appears to be consistent with stabilization needs.

We also see a pattern that recurring potential cost savings for many of these actions that scales up at a very significant level. In the pattern that emerged in terms of the action taken in states are very consistent with what the state of NC's

advisory group identified include energy efficiency and conservation which is the top wedge. Clean and renewable energy, we call that energy supply and the second wedge – transportation and land use efficiency, a very significant wedge that follows – agricultural and forestry conservation which appears to be a relatively small wedge in this diagram. But it maps the reality that much of the reductions potential in the two wedges that proceed it, energy supply and transportation and land use are derived from bio-energy whether it's ethanol, biomass, coal fired etc. So the use of biological resources, biomass in particular for energy production is very significant in terms of the pattern. We then see outcomes in terms of reductions from waste management, industrial process emissions which are smaller but none the less important. There is another wedge that we don't include in state processes because of purely federal jurisdiction which relate to aviation emissions and those are addressed through other means but we have included them here for purposes of illustration. Again this is a scale up analysis which would suggest that based on the data that was available at the end of the last calendar year that if all US states were to pursue similar ambitious climate action plan, the US at large would be on a pathway to reductions that are very much consistent with science and policy.

Finally, I have listed most but not all of the climate action targets that have been established by states based on the results of their climate action planning processes. Some of these targets were set in advance some of them were set as a consequence of the process and the results that it yielded. What we see in type that is too small to read very easily right now is a consistent pattern where states have used an index year, typically 1990 or 2000 and then established percentage reductions against that index year at future points and time. Typically an early period of 2010/2012, an intermediate period which is typically 2020 and a few cases 2025 and a long term target which is almost universally 2050. And so we see bench marks established for early, midterm and long term greenhouse gas reductions that states have established. This list is growing as more states take action and there are a couple line items here to be determined in the case of Colorado and Montana in particular. The advisory groups in those states did make formal recommendations on goals and they are under consideration for adoption by governments in those states.

Mr. Garrou: Thank you Mr. Peterson. Questions for Mr. Peterson?

Dr. Riggs: I just want to thank you for all your efforts and a very nice presentation summary of what is a very important part of this whole climate change business – and that's stabilizing the climate. It still bothers me very much that we are not dealing with, we've got 56 items in here or sections, one called CC5 deals with adaptation. And adaptation to climate change we have, I'm told, the thirteen billion dollar a year tourist industry a large portion of which is down on the coast. One storm could take care of what you've got out there as far as your benefits and we have conflicting processes going on right now that are all short term processes that's totally ignore what's happening out there on

the coast. If we don't get a handle on that the golden goose is going to go away and this deal with everything from floods and droughts which we're experiencing now, to storm impact. We have an excess of bridge that we're thinking about building out there that exceeds billion and probably a billion and a half dollars. And it's likely to be a bridge to nowhere. One summer, one storm could make that all gone and it's something that I think we have to get a handle on. I don't see any place in your scenario here where we can adapt or plug in the protection of our present economic system and our present resource space which is absolutely crucial as we move forward in this changing system.

Mr. Peterson: Thank you and I certainly don't disagree with anything you've said. I would only note that one of the outcomes of the process which was focused on mitigation was none the less by the CAPAG to identify the need for a planning process to develop a comprehensive adaptation plan for the state and under the crosscutting issues #5 recommendations which I believe the Commission endorsed at the last meeting. It is calling for a blue ribbon commission on adaptation that will presumably tackle this issue.

Dr. Riggs: So how do we make this happen? And when can it start happening? We need to get on with it. We've been lucky this year.

Brock Nicholson: Well I think that is an excellent question and point and as Tom pointed out that was in fact one of the recommendations. I think as I said at the outset, what we provided here are options to be considered by the policy makers in the state so I would assume that it would next go to whether it's the Legislature or combination of Legislature and the regulatory process and administration.

Mr. Garrou: Is the recommendation that there be a legislative commission?

Mr. Nicholson: I don't know that we spelled it out whether it's legislative or otherwise but I would think certainly that's a logical option and perhaps this body could further consider that as one of the options. I think certainly in debating the form of commission and how it is layed out the pros and cons would be legislative or otherwise. Certainly outside of what the CAPAG specifically did certainly we can envision certain advantages of that.

Representative Underhill: Thank you Mr. Chairman. I would just like to strongly endorse Dr. Riggs' statement. This is extremely important to those of us in the eastern part of the state. I certainly concur with all of your recommendations but we are ignoring a major vulnerability that we must address whether it's a blue ribbon commission, legislative commission. I don't care what kind of commission it is but we have got to get a handle on this particular problem. The sea level rise is going to doom a large sector of our economy in eastern NC and the state if we don't do something quickly. People will be displaced and it is very crucial that we address it sooner rather than later. Thank you.

Mr. Peterson: Other states are now actually developing adaptation processes and in some cases in parallel with the mitigation process, the state of MD for instance. So we are certainly seeing this, I think headed toward becoming the norm.

Mr. Nicholson: If I might very quickly add, the department and the division certainly are committed to assisting and developing such a program where we could do that.

Senator Pittenger: Thank you. Mr. Peterson I just want to clarify your response to Chair Harrison and I haven't read all of the 56 recommendations and action points. Is there a cost benefit analyses in these proposals?

Mr. Peterson: There is an economic assessment of the cost of implementation for each of the actions, the cost of removing greenhouse gases from the atmosphere for each so it is the development of information for a cost per ton of each of the actions.

Senator Pittenger: Then it does not include a cost benefit analyses for those proposals?

Mr. Peterson: This analyses and to my knowledge, no analyses other than some emerging work, the Stern report for instance have not used a monetized value for the avoidance of climate risk, so we did not attempt to monetize that because we are not aware of standard cost figures that we could use for that. So instead this is structured more as a cost effectiveness analyses to address risk reduction objectives.

Senator Pittenger: Follow-up? How many economists are with you on your center?

Mr. Peterson: Quite a few, including myself.

Senator Pittenger: Let me ask you this, in terms of your funding groups, Z Smith Reynolds, Rockefellers, have they been pretty aggressive in terms of this issue, is that shared bias that you have or is that a concern that it should be of some folks who are looking for an objective analyses. People pretty much have been on the front center who have funded your efforts in creating an urgency in this issue and it is totally anthropogenic cause.

Mr. Peterson: The work that we did in support of this process that was funded jointly by the state for DNER and private funders that have provided cost share was structured to support the specific purpose and goals that were established by DNER for the process. So our task was to support that purpose and the set of goals that were established in this process and that was the basis upon which the state and other funders have provided our organization support in terms of

meeting the objectives that were layed out by the state in this process. As we have brought cost share from private funders to this effort, by the way, we are extremely grateful to the Z Smith Reynolds Foundation and to others who have assisted. The role of private donors in public policy in this country simply cannot be overstated in terms of the importance of picking up the slack or resources that simply do not exist in the public sector quite often. But let me just say that in structuring those agreements we do not allow any contingent outcomes. So there is no agreement and we would prohibit any agreement that would specify any particular policy outcomes or other decisions that would be made by the process. The investment that they make is based solely and strictly on the process that we have been asked to manage by the state.

Mr. Profeta: I would just like to go back to where Dr. Riggs and Representative Underhill were and there was a comment that either Tom or Brock made at the very end of that conversation saying that a lot of other states had already created processes to address it. Is there any way that we could benefit from those other state's actions so that we don't have to start from scratch but we can actually take some wisdom from what they've done already?

Mr. Peterson: I think the states that are really hammering out the most current and comprehensive approach is the state of Maryland. We are conducting concurrent processes in MD for adaptation and mitigation and those are already being picked up by other states. So I would say yes, I would point to that as a primary example that you could use.

Mr. Toben: Thank you Mr. Chair. I am on the same line learning from the work of others. It has been a great deal of work in the last year or so on carbon dioxide and the carbon market both in the US and abroad. And Duke University through the Nicholas Institute has been involved in the net process and I would recommend and support a session within our next meeting that might more specifically address that opportunity as it relates to NC proper. There is a lot of data that has been developed over the last year or so that I think might give us some insight into how a carbon market cap and trade system might benefit the state. Thank you.

Representative Thomas: Thank you Mr. Chair. I sort of have a statement and a question here at the same time. I guess most politicians do that. I'm new to this group but it occurs to me that much like my mother asked me when I was in fourth grade, why would a person ever need a computer. She didn't understand that perhaps one day individual people might want to use computers. It was viewed as a business tool only. I think we all know now that everyone does use a computer and people can need them. I think that there is another point here to look at and that is where is the final solution, where do we find the final solution? And the final solution is a relatively unlimited supply of clean energy and we can talk about all the mitigating circumstances that we want, the economic impact of this or that, but in reality whoever solves that be it an individual, government

entity, a university, a group of folks, they are going to print money. They are going to make a ton of money. It will make the Alaskan economy with the pipeline look like some sort of lemonade stand. I would really like to see us come up with something that helps direct some energy and effort towards the ultimate solution. We talk a lot about the negatives and the bad things that are happening but if we can put a man on the moon and we can solve the Manhattan project and we can rid the world of smallpox, somewhere out there is a technological solution to this issue. And it is not just simply local abatement and we have a golden opportunity as a state, particularly in my region of western NC to seize that economic and environmental initiative and get them working together as opposed to having two diametrically opposed groups that are saying we are here to defend the economy and we are going to have to oppose the environmental initiatives and vice versa. There is an opportunity here for us to work together to direct both state and private resources towards a solution that really would have profound economic impact for all of our citizens. So if there are any suggestions in that positive manner I would love to hear them from any of our presenters. Thank you.

Dr. Phaneuf: Thank you. I would like to bring our discussion back to the economics a little bit if I could. So you suggested on a number of occasions the idea of negative cost and you were fairly clear in answering that indeed didn't consider the benefits. So we are talking about a negative cost estimate in the analyses? You talked also about consensus among groups throughout the country that these negative costs might emerge from these types of actions. I am an economist an environmental economists and I think I say with some confidence that there is a consensus among professional economists that you can end up with negative costs from these types of regulatory interventions. And I would just like you to address that sort of contradiction because I think that the consensus of mainstream economics is as strong as the consensus of mainstream science for warming is from human intervention. So to suggest that there are negative costs does this just sort of go against the consensus of science and if we are going to do that I think there has to be a response or reason for that and I'll listen to your response if I could.

Mr. Peterson: Well the report that the CAPAG developed and the reports and recommendations by other advisory groups across the US which include a great number of economists, whether they are mainstream or not I'll let them speak to themselves, have been developed through a technical consensus building process that has examined all of the elements of analyses that they felt were necessary to reach an agreement in terms of moving forward with a recommendation. And it has involved the participation of practitioners from various industries or organizations that would be involved and have been involved in actual implementation as well as other analyst. So these have been diverse groups. They have gone through a process using direct analyses and data or accessing other studies and then reforming and revising them based on what they think are more realistic assumptions to provide these results. The data

tells a different story than whatever portion of the economic community may add a theoretical level think that negative costs are not possible. I would observe that a number of businesses that have undertaken action, some of them very large businesses discovered that they also could achieve very significant cost savings by focusing for the first time in their business operations on greenhouse gas emissions. The consequence of that has been to identify new opportunities that there may not have been an adequate incentive to identify before and the net result of that has been actual after the fact savings. So I think that the consensus that I referred to is a consensus of negotiated agreements and recommendations that have come out of these participatory exercises. I would note that again a number of economists have been involved in these exercises and a number who I think are fairly well recognized have been involved in assessments that have been noted that our energy prices in the US today are high. They are likely to increase and for various reasons many of which are related to institutional barriers, we may not be achieving the level of energy efficiency and conservation that market forces alone would drive. I think what's behind many of these recommendations is an opportunity to bring down barriers so that the markets themselves can correct and go back and chase these incentives. So there is perhaps the market failure.

Dr. Phaneuf: Yes (inaudible) that material it is just that it really is a red hair, I mean when people like me who are trained to speak about these things and hear about negative costs immediately it doesn't sound credible. I think if these recommendations are to go forward I think that we need to come to terms with that because that will be the reaction among even the most liberal environmentally minded mainstream economists, I think. And then we can disagree on the people and so I wouldn't mind actually the list of economists that you consulted with, I probably know several of them.

Senator Pittenger: Thank you Mr. Chair. I'm just responding to Mr. Peterson's comments regarding the business world on interest. I remember we had three different business leaders come here, Mr. Key who is Sr. Vice President of Bank of America, Tom Darden, with Cherokee, and the man from DuPont, Mr. Bailey I believe, and all three of them outlined what their companies are doing as related to eliminating greenhouse gases and reducing them. Every one of them said categorically the government should not play a role in that. The free market should reign and allow technology and astrometry to work its way out of this.

Ms. Choi: Thank you. I just want to follow up on Representative Thomas' comments. We also agree that technology is essential for meeting carbon contained future and we don't believe it is just one syllable but a multiple prong approach that's going to be needed to get to where we need to be from energy production to production level goods and services. I look forward to working with you on that. We believe electricity in particular can be part of that solution and certainly we are looking at nuclear energy which is a large scale source of energy without the greenhouse gas emissions.

Mr. Urlaub: I just want to say I am glad that this issue came up because this was one of the rationale for Senate Bill 3 that recently was adopted from my organizations' perspectives. Is that when you have a base line in any project out business as usual, what the cost will be to society, to consumers, to businesses of continuing with business as usual and then model out an alternative, sometimes we find that the alternative net long term present value and estimated annual cost are less than what business as usual would be. And that's one of the ways that I was seeing the number here. That's presented in front that's been generated by the CAPAG process was that we're talking about doing something that we don't currently intend to do at least we haven't signaled that we intend to do it by our current regulations which brings me to the point made by Senator Pittenger. I would argue that regulations very much shaped the way our institutional barriers to adapting to climate change and mitigating it and a lot of work was done this year and a lot of work is involved in these 56 recommendations to actually remove government regulations as a barrier to realizing the cost effective measures that are in these 56 recommendations. So it is a little ironic that what we are considering in many of these instances is a changing government role or reduction in government role possibly to realize cost savings. At least that is how I am seeing it.

Representative Harrison: If I can respond quickly to Dr. Riggs comment about adaptation. We had contemplated introducing legislation for the long session this past session and we thought it may conflict with this climate change commission. Although I think it probably will compliment rather than conflict. So we anticipate having something for sure in the short session. Just to give you some confidence, a lot of us are very concerned about that.

Thank you Mr. Peterson for coming I had a couple of questions clarifying – I am looking at the summary and the chart on energy supply and there are three items on their ES2, ES4 and ES6 that don't have any figures associated with them and maybe you said this at the beginning. I am just wondering if it is because it is not quantifiable or if we've already had the (inaudible) of portfolio standard that you have cap and trade in there and then the (inaudible) I just wondering what the status of those recommendations are?

Mr. Peterson: I believe you are on Page 1-13. On ES2 the shaded region is simply because underneath that umbrella there is an ABMC, a lot of print there. The group did not choose to provide a quantification of the potential impacts that either a carbon tax or a cap and trade program at the state or multi-state level in that recommendation as I recall is more qualitative in this structure as well as ES6 and (inaudible).

Representative Harrison: If I could just follow up? On the public benefit charge could you elaborate on the discussion regarding that particular issue please?

Mr. Peterson: I would like to – I am truly afraid I may not do it justice because I cannot off the top of my head remember all the details that were involved there. You might invite other members of the group who were involved in that discussion. I think certainly the public benefits charge is one of the areas where we see a positive cost outlay leading through investments to not only emissions savings but potential economic savings. But that does involve a transfer payment and so as I recall there certainly are concerns about the level of transfer payments and then the need for finding ways for the folks who make that payment, the losers if you will, to benefit from the pool of winners and benefits that result. Those are just a couple of the many things that I recall.

Representative Harrison: Ok thank you.

Senator Pittenger: Thank you Mr. Chair I would just like to respond to my good friend Mr. Urlaub. Seems to me that if there is any consideration to impose a larger tax on energy, electricity or gas that it is certainly going to be the growth of the economy and opportunity for research and development for improved technologies. So I think that would be an (inaudible) for the government that would certainly stifle what our goals might be.

Dr. Riggs: Representative Harrison, if the last legislative session did not consider this because it would conflict with the Climate Commission that would imply to me that the Climate Commission needs to get on the stick and we have all sorts of things in the mill that are going on also in the legislature right now. Decisions that are major decisions that are very short term coastal decisions that are going to be terrible with respect to this whole adaptation business coming down the road. We don't need to start hardening our shore lines for example and I did not understand your statement I guess with respect to that.

Representative Harrison: If I can just respond. I talked to someone on the staff and other colleagues and I think we felt like this Commission had addressed adaptation, it might continue to be addressing adaptation in this interim period before the short session when we would make our final recommendations to the Legislature and that would be one reason for opposing legislation. I understand the urgency and I agree with you, I am anxious about it too.

Dr. Riggs: So when and how do we go about doing that? I put a poorly worded recommendation on the table to try to help get something going. I am not sure how we proceed.

Representative Harrison: If I can respond, I expect legislation to be introduced and I'll introduce it with Representative Underhill to establish an adaptation commission, how it is comprised, whether it is legislative, whether it is administrative or if it is highly imposed, I pledge to you that we are going to do something about that beginning in May.

Dr. Riggs: Thank you.

Brock Nicholson: I might make a couple of quick closing points. As you can see we had quite a stack of items here and a lot of considerations for future policy development perhaps through legislation and so forth. Again we are committed to help however we may in terms of helping put that together. I will say as far as our remaining schedule I may have sort of implied that, but our intent is to finish the comment work by the CAPAG members on the report, get that finalized and then along with placing the Appalachian work at least the executive summary of the report so that it all can be together and we will get all of this finished by the end of the year. The major thick piece that many of you already have, we don't expect to change much in substance but more in just details and refinement. So that is our game plan to finish up by the end of the year. The CAPAG is in a sense still convened to be available for assistance on technical issues with the Commission at least through the early or mid part of 2008.

Mr. Garrou: We think we can finish this next session in half an hour and I am afraid if I let you go to lunch, I will not see many of you when we reconvene. So with your permission let's soldier on and see if we can finish by 1:30. The next presentation is David Ponder. I think Brock is going to introduce him.

Brock: Dr. Dennis Grady has been helping with this project and we have a graduate student, David Ponder, who has been most of the heavy lifting on this but I think Dennis will give an introduction.

Dennis Grady: Thank you co-chairs, thank you Brock. Let me be very, very brief given the lateness of the hour here. We were approached by the Division of Air Quality I am the Director of the Appalachian State University Energy Center. We were approached by the Division of Air Quality in July if we interested in taking on a project. The project basically entails taking the information that you see in the technical report from the CAPAG technical working groups running them through and then put output models that we have developed at the Energy Center that we've developed basically under contract with the State Energy Office to estimate the economic impacts of various policy alternatives for the Energy Policy Counsel. Driving the train has been my colleague, Jeff Tiller and my graduate assistant, David Ponder. I want to emphasize that what we have used here in terms of the analysis is the information that was given to use by the technical working groups that Tom just mentioned. I also want to emphasize that these are preliminary draft results they are a work in progress. We still have about five to six more weeks of analyses to do. We haven't even completed the analyses and all of the recommendations. So with that said I'll turn this over to David and he can walk through the process of the model, the assumptions and what we found.

David Ponder: Thank you Mr. Chair, Madam Chair, members of the Commission, members of the audience. My name is David Ponder. I am a

graduate student studying public administration at Appalachian State University and I am happy to be here with you today and talk about the work that we have been doing. I think all of you have the slide (Exhibit H) that you will see on the screen. What we will do today is briefly talk about how the input/output models that refer to as the NC energy scenario economic impact model works. We will talk about the selection of the CAPAG policy recommendations that you've just heard about from Tom Peterson, a work considered. We did not model all 56 of the recommendations that are presented in that report. Next I will talk about sort of how we treat the data and how that data is handled in the model and then I'll talk about some of the preliminary results and what we look forward to completing in the coming weeks.

The model that we used as Dr. Grady mentioned was developed for the NC Energy Policy Council under contract with several recognized experts in the field. It has also been peer reviewed by Dr. Adam Rhoades out of the University of Southern California and the model has served as the basis of similar reports conducted in a number of other states.

Senator Pittenger: Dr. Rhoades' PhD what is that in?

David Ponder: I believe it is in Economic Geography. Just a little bit of background on how input/output modeling works. The concept of input/output modeling was conceptualized originally by Nobel Laureate, Loffly Lantif. Dr. Lantif basically came up with this concept of how sectors of the economy relate to one another. And basically what you can do is you can look at the actual transactions that occur in the economy and then describe those relationships. And if you will, think of it as a basket of goods and services, we as consumers demand goods and services for things like groceries, transportation, utilities, health care. And in turn those industries that provide us those services demand goods and services from other sectors in the economy. The health care industry relies on the pharmaceutical industry, relies on the marketing industry, so we are all connected, if you will. What happens is as we change the relationship in the economy as we change the demand for goods and services there is a ripple effect that goes out throughout across the economy. And essentially what the model does is it measures the multiplier effect of changes in the way we conduct our investment. At the core of the model is a 39x39 economic sector matrix like I said describes the consumption and production functions of each of those sectors in the economy and those are derived from the IAP group in Minnesota which stand for Impact Analysis for Planning. It is the standard source of commercially available input/output data which is itself derived from the Bureau of Labor Statistics.

The model captures the direct/indirect and induced effect in the economy associated with changes in demand. The direct effects are those direct changes in demand. Say we build a new ethanol plant in NC, that investment creates a direct demand for construction and other goods and services. In turn the

construction firm that builds the bio-ethanol plant demands goods and services from other industries and then those induced effects are the recent wages paid the laborers building the plant. What the model does is it calculates changes in total employment and I want to emphasize here that it is total employment and part-time employment. The Bureau of Labor Statistics did not collect a per hour employment data for every sector of the economy so it is difficult to translate that into fulltime equivalents although we're doing our best to figure out a way to do that. The other thing that the model calculates is changes in income. If we are employing people in a given sector based on the average wage in that sector, what is the effect on earned income? And in turn what is the effect in terms of total value added, which is income as well as rents, royalties, profits and the IAP model captures some indirect business taxes, things like sales and excise taxes, although it says not captured income tax.

Like I said, it was not possible in the six week period that we were given to conduct this analysis to do a thorough analysis of all 56 options considered by the CAPAG group. Instead we bundled 31 policy options into 24 analyses, seven from the energy supply sector, 10 from the residential/commercial, and industrial sector, 10 from the agricultural, forest and waste sector, and four from the transportation and land planning. In aggregate, these 31 policies that we examined represent 90 percent of the greenhouse gas emissions reductions in the CAPAG process.

This is a really important slide and I think it will help explain to us how the model treats the data. As Dr. Grady said, what we did is we took the assumptions from the CAPAG working groups and sort of parsed them out into outlays, investment and energy reductions and dollar savings as a result of energy efficiency gained, typically. An outlay is just what it sounds like – the program costs something to implement, that means there is less money in your pocket and because you are spending it on something else. Your rate may go up and so therefore you're spending less money on the typical basket of goods and services. On the other hand the money that is being outlaid is being invested in other technologies. It is being invested in energy efficiency, it is being invested in clean renewal energy technologies, it is being invested in biomass and bio-fuel type technologies. So that is a positive impact to the economy. On the other hand, if we're investing in efficiency and clean renewal energy, we are not investing in conventional sources of energy. So we want to take for account the displacement of that investment and not a curse.

Additionally, you want to consider the net impact on interest payment. So if a given investment in an alternative technology yields a given gain in interest payment, you want to account for that. On the other hand, if you're not making interest payments on your conventional resources, that's a negative. So depending on the scale of the policy those interest payments are a plus or a minus.

Finally many of the policies considered by the CAPAG results in reductions and energy consumptions, because you're not spending money on utility bills that creates increased personal cash flow and on the business side of things, it increases cash flow for businesses that is freed up for other investments. And so that is typically a gain in the economy. Conversely, if you're not sending money to the utility company, they are not realizing the benefit of that revenue until you want to take into account that as well. So what you end up with when it is all said and done is a total change in net demand for the basket of goods and services based on the policy under consideration.

Those net changes in demand are then plugged into the input/output model and generate the impact that we previously discussed - impact in terms of employment, impact in terms of income, and impact in terms of total value added. Based on preliminary findings these are some of the results. If you look at the entire study period, 2007-2020 you see a net gain of 328,738 jobs. I would not worry about the 38 because in all economic modeling there is a little give and a little take. But I think the important thing to take away here is that the trend is positive. There are particular steps of policies that tend to have more positive employment impacts particularly in the agricultural and forest industry. That's because there's a labor intensive industry and so investments in those are primarily local investments as well. So you see bigger gains in those sorts of policies.

In terms of cumulative impact on personal income it is on the order of 14 billion dollars over the study period and in terms of cumulative value added over the study period it is on the order of 20 billion dollars. Just to give you a little bit of perspective on these numbers, in the base year that we looked at which was 2004, that was the latest year data from INPLAN was available when we started this process. Total jobs in the NC economy were about five million, total income in the NC economy about 250 billion and total value added in NC on the order of 300 billion. So again we see mildly positive impact, but in terms of the scale of the economy these are not earth shattering figures.

Next I want to turn to some of the specific policies that we model so that you can see how those come out. We completed analyses that chose the energy supply options 1 is ES8 which is essentially a municipal biogas policy that call for capturing methane from wastewater facilities to generate electricity. Clearly the big blue there is what is going to capture attention. That's a combination of Senate Bill 3 that was modeled by the CAPAG group as well as some additional energy production tax credits for renewable energy and accounts for a little bit of the biomass that significant overlaps in the biomass analyses conducted by the agricultural and forestry groups and the energy supply group. So that biomass component most of that is already captured in the REPS type analyses. As a point of reference, these values are consistent with the results from the LaCappra study. There is just (inaudible) which was talked about earlier by Mr. Givens. The LaCappra study looked at a 20 percent, a five percent and I think a

10 percent and it included some energy efficiency components in there as well. The primary reason why the results are similar is we followed the same logic as the LaCappra study which is a fairly conservative assumption that the only thing that's sort of gained in the local economy is the value of construction dollars. That is a conservative assumption because more than likely you are going to have, if you move in this type of direction you are going to see industry form, there are already (inaudible) industries, green collar industries in NC but we want to stay on the conservative side and be consistent with something that we thought you all were all familiar with.

Ms. Choi: David just real quick. Seven recommendations that you modeled were energy supply. It only shows three here, 8, 1, and 2.

Mr. Ponder: That's right. We've not completed the analyses of the advanced call policies and we've also done a PBS analyses which was energy supply option #7 and we're still trying to figure out the way to treat that because the way the CAPAG treats it, it counts all the efficiency gains in RCI2 and so we are trying to figure out what is the appropriate level of a PBS to analyze. Does that answer your question?

Ms. Choi: It's a total of seven. I don't have the complete list in front of me but in the end it is seven.

Mr. Ponder: Another perspective on those numbers is instead of looking at the jobs impact is to consider the total value added. As we talked about total value added is income plus profits, plus some indirect business taxes and again you see the general trend is toward an increase. That is because as the policy is ramped up as the REPS bill comes on line you see greater investments in renewable energy technologies. So that typically accounts for that ramping affect that you see here.

Next I want to talk about the agricultural forestry and waste options. There are a number of those options that we modeled. Clearly the ones that stand out are our policies to promote cellulosic ethanol and policies to promote the conservation of farm land and forest land, followed up by investments in bio-diesel productions. The goals for cellulosic ethanol production are fairly aggressive. My recollection is that it is a 20 percent ethanol displacing petro derived gasoline by 2020 and again you see the ramping of the policy effect. In essence, what you have to do to get that much ethanol produced in NC which is what the policy calls for, you have to build a lot of ethanol plants. So that is what you see there those construction jobs associated with building ethanol plants.

The conservation easement policy is a boom queue of households because it essentially is a cash payment, if you will, to the households and then the model assumes and goes out and spends those dollars on its typical basket of goods and services. So when we all get our tax refund check we go out and we buy

that HD TV that we've been wanting all year long. So that is sort of the effect that you see there. Then the bio-diesel policy again is a fairly aggressive standard, I think it is 20 percent again by 2020 but what we're talking about is a different scale. The diesel consumption in NC is less than the gasoline consumption in NC so the impacts are less.

This is another way to take a look again at these policies and again it is important to note that some of the policies have a consistent ramp up of in total value added. But you can see that not all of the policies create total net value for the economy. The recycling policy – now that one may be a little deceiving because of the number of significant digits revealed here in the graph. But in line, per policy 13 the urban forestry measures for example while you have an initial investment in planting trees around houses, the assumption is that you only get so much energy savings from that tree planting. And by the end of the study period the costs are outweighing the benefits there.

Next I want to turn to some of the demand side related options what I refer to as residential/commercial and industrial options and what there net jobs impact are. Clearly the big job creator is funding for energy efficiency, RCI1, 2, and 11 is a combination of a public benefits fund which is I think a one percent public benefits charge and then a one and one-half percent utility revenue, dedicated one and one half percent of utility revenue to efficiency. So that's two and one half percent and that will put you well within the top ten states in the country in terms of investments and energy efficiency. Essentially what you see here and again we follow the LaCappra assumptions about how efficiency dollars are spent on a combination of purchasing retail goods and services and it is also a combination of installing the goods that you buy. So you're buying a new dryer and washer, you're buying a new heating system or air conditioner for your home but then you have to hire someone to come in and put it in. You see the gain here from both the retail sector in the economy seem to gain in spending there. The gain in construction related type jobs in installing that equipment but again the peak here, the curve comes from the energy savings. By the time the policy is fully implemented, you are getting dollar savings in your pocket and again the assumption is that you or if you were an industry, you're going to go and spend that on other goods and services as the data would suggest.

The next big gainer here is building codes. Again it is a combination of increasing investment and construction and if you think about it the constructors sector is a fairly laboring intensive secretary of the economy. But again you get sort of in the near term some construction jobs but really when you see the curve starting to come on that is where you're seeing the gain in energy savings. Because your energy bill is less, you're spending money on other goods and services in the economy. The other policies of note are the policies for combined heat and power so that is sort of an industrial and commercial level efficiency measure where your use the thermal energy associated with producing electricity to do some other things. That's again driven by investment in

construction and the other policy bundle that we looked at 7 and 3, sort of what is termed as a beyond code policy and government building policy. So these are government buildings moving beyond the conventional building code standard and having a number of other commercial and residential type buildings meeting higher than the recommended energy code standard. So again you are getting investments in construction and because you are not spending your dollars on electricity, you're spending it on other goods and services.

This slide is I think one of the most interesting slides and it really illustrates what was talked about at the beginning of the last presentation is if there are short term costs associated with implementing some of these policies. And it isn't until the long trend that you really start to see the gain. The screen is sort of smooching everything together a little bit but I think you can read from that first line. You can see that the PBS type policy you get sort of an initial rush of investments to meet other policy after a while the displaced utility investment sort of catches up and then it is not until sort of the end of the study period that the energy savings again catch up with the displacement in other investments. You can see that trend sort of consistently throughout. With just one note on RCI9 - that is a policy to encourage green power purchases by state government and so what you see there is sort of the short term investment in renewable energy, short term investment in construction jobs associated with acquiring those resources and then by the end of the study period it assumes that those facilities are already filled and then you sort of go into an operations and maintenance type mode. Then by the end of the study period you actually start to see a slight downward trend.

The next steps in the next five to six weeks include a complete and thorough betting of the assumptions that we've made and how we treated the inputs provided to use by the CAPAG facilitators and their team of professionals and economists. They have assisted me greatly so far in treating the data but like we said at the outset, these are preliminary in draft results. We want to make sure that we get this right because we understand that this is an important study and we take seriously the work that you all are doing.

We also need to complete our analysis of the transportation/land use option. We have not begun that process we're working to make sure that we're treating the data appropriately for the input/output model. We hope to initiate that work in the coming couple of weeks. And then finally, we want to complete a final report which we will make sure that each of everyone of you receives a copy of so you'll have plenty of reading to do. This will help you go to sleep a little bit faster.

Just in conclusion I want to offer some thanks to the team of CCS economists and particularly Dan Wei and Tom Peterson who have been invaluable to me in handling these data inputs and also I want to extend thanks to Skip Laitner who is now with the American Counsel for Energy Efficiency Corp. In economy Skip was the original brain child behind using input/output analyses to study the

economic input impact of efficiency type policies. And then of course the team at ASU Energy Center, Jason Hoyle, Jeffry Taylor and of course Dr. Grady.

Mr. Garrou: Thank you Mr. Ponder. I take it you are also looking for input from us as to how this data might be better presented or improved. So if we have that sort of input from the Commission that would be great and also questions.

Representative Wilkins: I guess I wasn't quite prepared. Thank you Mr. Chair, I am on page 3 of the handout which would be, I'm looking at the middle frame which would is your 8 overall frame. I was out of the room very briefly and maybe I am asking for something that you've already given us. Is there a margin for error in these numbers?

Mr. Ponder. This is not a statistical sample. This is based on the data that is used to drive the model as based on the actual input/output account developed by the Bureau of Labor Statistics and Bureau of Economic Analyses. That data is treated by the INPLAN group in Minnesota to create what are called an industry by industry table. Those are the tables that describe the relationship between given sectors. So you and I for example have a particular demand for goods and services as our income changes our ability to demand those goods and services changes and so this is really an accounting method versus a statistical method. Talking about margins of error doesn't really apply.

Representative Wilkins: Mr. Chair may I follow up? I would still like a ball park guess. I don't care if it is two percent, 25 percent, 50 percent I think it is important that we know whether it's two or 50. Could that possibly come at some later point, even if it is a best guess?

Mr. Ponder: The technique involved here is a technique based on a financial accounting. The outputs that we're getting are as good as the inputs that we're given and certainly we plan on conducting sensitivity so we will manipulate some of the assumptions. Say for example, some of the financing assumptions can play an impact on the ultimate outcome of a given policy. So we will present those sorts of sensitivity analysis in the final report but they will not be margins of error. What we can do is provide the sort of, if you change this assumption, this is what happens.

Representative Wilkins: I just think some sort of guidance is important for us if we're expected to be on the ball policy makers here.

Mr. Ponder: Yes sir – we will certainly take that into consideration. Thank you.

Ms. Choi: David I raised this to you earlier and I just have a question. The INPLAN matrix is a static matrix that assumes that the cost of producing the unit of goods or services doesn't change. But it looks like a number of the recommendations would impact the cost of production for energy or for farming,

food and so I am just wondering if maybe there is a better model to use to determine economic impact. (Inaudible) seems this model use for, for instance at the federal level and looking at the economic impact of some of the federal proposals for cap and trade, I'm just wondering if there might be a different model that we could use that would take into account the dynamic changes and how you produce goods and services under these type of recommendations.

Mr. Ponder: There are a number of other types of input/output models and this is the model that we have and that we can afford, frankly. I would say this about the model and some of these dynamic issues that you raised. There are some things that we do differently in our model that typical implant modeling doesn't do. So for example, we take into account changes in labor productivity. So as labor productivity goes up you see a decline in unemployment in that given sector of the economy. So we do adjust over time for things like labor productivity, there are feedbacks for price changes in terms of fuel and we are currently working on what we call the Adam-Rhoades deflator. Which is exactly I think the point that you're getting at, which is if you have policies that increase the cost of electricity then you may have sort of a level of elasticity associated with where the consumption of electricity may go down, depending on what the price is. We are in the process of incorporating that feedback mechanism as well.

Senator Pittenger: Thank you Mr. Chair. Mr. Ponder you're here for economic analysis of your climate mitigation strategy and I do appreciate your role in terms of political scientist, public administration. I respect that but were there some environmental economists PhD trained folks who gave input in this process that were on your specific team?

Mr. Ponder: Yes absolutely. As I mentioned Dan Wei who is a PhD economist I believe her degree is again economic geography. She is also at USE (inaudible) provided a lot of help and assistance in need kind of climbing the learning curve, if you will. There has also been as I said review by the other facilitators involved in the technical working groups, Jeffry Tiller who was unable to be here, his master's dissertation was in input/output analysis and then we've also worked with Skip Laitner who is formerly of the EPA and now is at ACEEE. He is widely recognized as a pioneer in this type of analysis.

Senator Pittenger: Mr. Chair at some point I was just like to make a recommendation if we could have Dr. Ed Erickson a member of our Commission who is an environmental economist speak to us on this I think it would be great.

Dr. Eggers: Thank you and Thank you for your presentation. I am interested in the sensitivity analysis, tornado diagrams too I think that would be fascinating. This is less a question for you than a statement for the Commission and I think what this is bringing to light is something that we need to consider in our role of making recommendations. And that is these jobs are real jobs that I think will be

out there, plus or minus some amount. We need to make sure people are trained to carry out these jobs. I was invited to testify before a House congressional subcommittee and small business. One of the other people testifying, we were talking about energy issues, one of the business owners testifying said he had to go to Atlanta, he's in TN, to find a company that could give him energy efficiency lighting in his manufacturing facility. And then in TN he could not find an electrician to install it and he had to bring in an electrician from GA who is trained adequately to install it. Now in Asheville where I'm from, Asheville-Buncombe Technical Community College is trying to get funding for a pretty large scale program to help people that didn't have green collar jobs basically, electricians, plumbers, builders, and so on. And in our university and community college systems we need to be training people who have the knowledge to do this because traditionally trained folks need to be re-trained in order to really do several of these kinds of jobs well. So that is something I think as a Commission we should consider and I would also very much echo Representative Thomas' earlier statement about investments and research and thinking outside of the box. Because while we are making good progress we are talking about 1990 emission levels as if it is a great goal. But it is not the ultimate goal it is kind of like smoking three packs a day and trying to get down to two. That's a good thing but we actually need to go far further than that and that will require technologies and things that we don't currently have. So as a Commission I think we need to look at funding research to support those initiatives as well. Thank you.

Representative Harrison: Thank you Mr. Chair. Thank you for your presentation, actually I have a clarifying question on a slide. You were giving us the context of what the current situation is - I thought you said five million jobs in NC and 20 billion in accumulative income, is that correct?

Mr. Ponder: It is 250 billion in accumulative income, 304 billion in total value added. This is as of 2004 and those values are derived from the IMPLANT data center.

Mr. Givens: David when do you anticipate that you will have your final work product?

Mr. Ponder: Excellent question – our current goal is the end of November.

Mr. Garrou: We have two young women in the back who are Annie Delmedico and Lorna MacAllister who come from the Montessori School of Raleigh and they have one or two questions. Maybe each has a question. So I'll recognize them.

Ms. Delmedico: Earlier you were talking about payments, would there be any taxes that would be forward to pay for solar technology and CO_2 consumers, etc.?

Mr. Ponder: I think the way some of the policies are written they are not taxes per say. Typically what they are, are surcharges to a monthly bill that you get from the power company. So you pay an extra dollar a month or two dollars a month on your power bill and that goes into a big pool of money. Then the power company takes the money and invests it for all of us to reduce our energy consumption.

Mr. Garrou: Were you Annie or are you Lorna? You're Annie.

Mr. Garrou: Thank you girls. Thank you, David. That was a good presentation, is there any other discussion or announcements.

Representative Underhill: Thank you Mr. Chairman. In light of several of the comments that were made earlier in this session while Tom Peterson was speaking, I would like to see if we could have a speaker from the state of MD to address our Commission about what they are doing in MD and perhaps we could get some people from MD and maybe their consultants down to talk about that.

Mr. Garrou: On the adaptation issue.

Representative Underhill: Yes whatever they are doing in MD. Thank you.

Dr. Eggers: Just a note. The payback period on the lights of that the manufacturer installed was six months.

Mr. Givens: I would just observe generally that the co-chairs and counsel are in the process of developing a plan for the work of this Commission from now until the 2008 regular session the so called short session. I am talking to various folks in connection with that and we will be talking to others over the next few weeks. If you have particular suggestions or input such as Representative Underhill's, we would be glad to have it and to factor it in our thinking. We hope to have a cohesive and meaningful plan of activity from now until this Commission is schedule to conclude which is technically the 15th of April but I think we will be working right on up until the Short Session convenes. One of the issues before the Legislature and what this Commission may well want to weight in on is what comes next in terms of not only adaptation of which Representative Harrison has spoken to and other aspects of the climate change and how that might continue to be addressed on a ongoing basis.

Mr. Garrou: I've been asked to remind you to turn in expense reports and unless there is any other business we are adjourned for the day. Thank you.

Respectfully submitted,

Mr. John Garrou
Co-Chair

Thelma T. Utley
Commission Clerk

APPENDIX

Exhibit A	Visitor Registration Sheet
Exhibit B	2007-2008 Membership
Exhibit C	Agenda
Exhibit D	Update on International, Federal and US State Action on Climate Change – Patrick Hogan
Exhibit E	Session 2007 Legislative Fiscal Note
Exhibit F	NC Legislative Commission on Global Climate Change Brock Nicholson and Tom Peterson
Exhibit G	Climate Action Plan Advisory Group Recommended Mitigation Options for Controlling Greenhouse Gas Emissions
Exhibit H	Economic Impact Analysis of Bundled Climate Mitigation Options – David Ponder

DRAFT

Global Climate Change Commission Meeting
Thursday, 4 December 2007
10:00 a.m.
Room 643 LOB

The Legislative Commission on Global Climate Change met on Tuesday 4th December 2007 in Room 643 of the Legislative Office Building with Representative Pricey Harrison presiding. Other members present were: The visitor registration is Exhibit A.

Representative Harrison called the meeting to order and gave the floor to Mr. Givens, Commission Counsel, for introductory remarks.

Mr. Givens called the commission member's attention to revisions in schedule of the agenda in respect to the February 11th and 12th meetings. Considered will be Emerging Issues Forum, which is going to focus on energy this year to be held at the McKimmon Center, NCSU and a business Meeting 2:30 to 3:45 in Room 2, McKimmon Center, NCSU . Mr. Givens advised the commission that there would be a registration fee but legislative members on the commission would not be charged a fee and that other members of the commission would be reimbursed at the discretion of the Emerging Issues Institute. He reminded them that they needed to turn in reimbursement forms. Mr. Givens announced that Dr. Pachauri, The chairman of the International Panel on Climate Change, was a co-recipient of the Nobel Peace Prize in 2007, would be a speaker at the forum. Dr. Pachauri is also a graduate of North Carolina State University. Mr. Givins informed visitors that in conformation with open meeting rule, the public would not be responsible for registering or paying a registration fee to attend the Forum

Today's agenda involves an in depth analyses and decision points with respect to the recommendations from CAPAG of Climate control. There were five technical working groups. Today the commission will be working on Agriculture, Forestry, and Waste technical working groups. Some members who have been involved with CAPAG are Robert Slocum and Paul Sherman. Hopefully we will have an open discussion and motions decisions that you want to make concerning the recommendations that have been made by CAPAG. Counsel again reminded the members of the Commission to turn their reimbursements forms and reminded visitors to sign the Visitors Sign in sheet at the rear of the committee room.

Representative Harrison introduced Timothy Profeta, speaking as Jane Pryor, Federal Director of the Nicholas Institute for Environmental Policy Solutions to report on federal activities related to global climate change. He in keeping with the pursuits of the commission should some degree be well calibrated to what the federal government may or may not do with Climate change. So that NC as a state is well positioned to takes opportunities at the Federal Action. Mr. Profit told the commission that the Lieberman Warner Climate Change Bill, a proposal to cap Greenhouse Gases, has passed out of sub-committee and is being considered tomorrow in the Senate Environment Public Works Committee. . Members hope to vote it out of Committee and put it to the Senate floor but the vote is predicted to be very tight (one to two votes). In his opinion the bill will not be law this year but it will be in its final form. The bill is a proposal to cap greenhouse admission gases utility such as 70% reduction by 20-50 and trade entities under the cap or sell to another group who wants to w the bill has a robust program for Forestry and Agriculture sectors of the economy. Senator Pittenger had a question concerning how the bill relates to HOC 23. Mr. Profeta explained that the bill covers all six major gases. There are two programs under the bill that allow grants to get sellable credit. Dr. Smith had a comment on how to deal with Allocations in this bill. There has been a question and much discussion concerning the percentage of auctioning off; the auctioning off of pollutants has risen from 24 % to 74%. The question is should it be

100%. Tim Rogers at Duke has been working on this. Over the next 18 months this there will be robust discussion concerning the auctioning off at 100%. Dr. Smith offered to share with any one the testimony that has been concerned with the request to auctioning at 100 %. Mr. Profit informed the commission that the Energy Bill is presently in Conference Committee. The provisions in this bill are renewal portfolio standards, fuel economy efficiency standard efficiency fuel standard for vehicles and a robust tax package. The bill does not have the support in the Senate. It has been very controversial and unfavorable. There has been a deal struck with the auto industry. The fuel standard will be raised economy from 35 miles to 22 miles an hour. Mr. Profeta does not believe the renewal program will become law.

Next on the agenda is Mr. William L. Chameides, new Dean of the Nicholas School of the Environment. Duke University. Mr. Chameides will discuss the extent to which carbon offsets may be reliably identified and qualified. New book, The Earth's Farms and Forests Low Crab Economy written by Mr. Chameides. What are offsets-they are Greenhouse gases. You can offset Carbon Cycle where Carbon Dioxide is taken up in the atmospheric Co2. Please refer to Exhibit one "Real and Verifiable Carbon Offsets" – Mr. Chameides presentation. Co2 is increasing because fossil fuels are being burned. We need to quit burning fossil fuels. Temporary Solution to the problem is land management. We need to capture methane emissions from manure, land fills etc. Farmers could be paid to capture the methane and store more carbon in the biosphere. Tim Cerich asked if there are any new programs being considered. Dr. Chameides answered that there is a bill in congress to cut CO2 about 15 % but he feels that it should be 20%. He said that the ideas of offsets have to be correctly done and additionally, it is important that the process for creating offsets be real and variable. Offsets have gotten some bad press and cited a web site www.cheatneutral.com to the commission. He stressed that offsets must be creditable and that the regulators, buyers, and people must have confidence that offsets are real. The process for getting credible offsets is as follows: 1.Set a baseline (what emissions would be in the absence of the offsets), 2. Assess leakage (Sequester carbon) for example you decide not to cut down your trees to send to the lumber company and save the carbon, but your neighbor cuts his trees down and sends the lumber to the pulp and paper mill to make up for loss of the lumber that you decided not to cut. Then, you do not get credit for preserving your trees. This is leakage. 3. Measure the changes in the soil, take samples of the soil and have it tested, 4.IndependentlyVerify (have an auditor verify what the farmer has done), and 5. Register offsets. Keep a detailed account of what one has done in the registry of the offsets.) The most important action is measuring regularly samples of soil to show carbon is building. Dr Chameides told the commission that off sets have a huge potential in North Carolina. Senator Albertson asked if anyone currently was doing No Till and would we have to do soil samples overtime and how much. Dr. Chameides answered that some projects were in effect and that numerous experiments were being done to show that No Till builds carbon in the soil. Auditors must verify. Representative Allen asked if sequestering forestry meant delaying cutting and the answer was yes. She did not feel that it was fair to not receive credit for sequestering and would like to hear from the forestry Association. Dr. Eggers stressed that the "name of the game is sequestration." She brought up the action "Bio Char" where carbon gets re-admitted to the earth. What if people sold land to people who would not cooperate and continue to sequester. Dr. Chameides explanation was that to qualify for offsets a landowner needs to own the land. If he sells it to a company then the company owns the carbon in the soil. There must be a contract. If carbon returns to the atmosphere then the owner needs to make up offset in another way or someone might least the offsets such as a power company. Representative Harrison asked what is "Bio Char"? The answer was darker soils were found in the Amazon where people had settled and would bury organic matter and char the organic matter. They found that plants grew better and faster, the ground retained water and the agriculture flourished. It was found that carbon put in the ground a long time ago is still there. Bio Char is a good sequestion solution. Co- Chair Garrou wanted to know cost per ton of carbon in monitoring and assessing leakage. Dr. Chameides said that it is a great ;opportunity but we must also recognize that if we're in a capped economy we are letting the market place to sort out and individuals will try to make a profit, others might try to innovate and try to figure out how to do it a cheaper way. He

did not necessarily want to get into the economics in great detail but felt we should allow land managers and farmers to compete in the carbon market. It could be a great boom for what's in the climate. Tim Profeta commented that provisions in the federal legislative process concerns putting governing money into projects in and marked and lowering transactions. Representative Carney wanted to know where to register offsets. Mr. Profeta said that were a lot of places but named The Chicago Climate Exchange in Chicago and Environmental Resources Trusts. He said that Project managers will do registrations. Dr. Chameides said that there are different registers and they have different standards. Some are more stringent than others on what they will register. The next question was asked by Co-Chair Representative Harrison. She wanted to know what is going on at the National level. Dr. Chameides said that we are much further along that the European Countries we have a much greater potential than Europe to be competitive internationally. What is not appreciated by many is the fact that 20% of CO2 is emitted from carbon off sets in Europe is the burning of the rain forests which take place in Indonesia land Brazil. There have been a number of proposals made. One is Compensated Reductions which would compensate those who would reduce the rate that deforest which would help in lowering CO2 emissions and would be rather inexpensive. This proposal is being discussed in Bali as we speak. Mr. Profeta added that Europe doesn't have offset provisions. Some of the Europeans are doing projects in the US. The Europeans look toward a voluntary market they have no mandatory system. Representative Thomas asked if there was no standard law for agencies that sell offsets; no federal policy in place it is it all voluntary. Dr. Chameides said that federally have a standard for Climate and, Representative Thomas felt that there needs some law in place Tim Profeta answered that Federal legislation is looking at one standard VCS and a CFTC would regulate the commodities Market and should have some rules is place in a couple of years. Mr. Sherman asked if there was any consideration to alternatives to monorting individual projects because of the problems of leakage and terms of contracts, etc. Are not alternatives that we can look at statistics of the average of research that are based on location, soil samples and climate? Should we be looking at a modification factor that devalues the credits based on the perception of and leakage and regression of certain percentage of those credits? Dr Chameides said that leakage is the most easily best developed through economic modeling, elasticity of price, and demand. There needs to be more modeling than monitoring; however there needs to be some monitoring. Uncertain results will devalue the offset. Mr. Sherman asks Mr. Chameides if his proposal is to do more modeling than monitoring depending on the project and he answers yes. Dr. Eggers wanted to know how we deal with double dipping in off sets. Dr. Chameides response is that in principal it is additionality. One has to show that as a result of your activity, you have decreased the amount of CO 2 in the atmosphere. Dr. Chameides used the example of Corn enathanol – Corn is taking the place of soybean crops in the United States. however biofuel might not be an offset. Brazil and other countries are cutting down their rain forests in order to grow soybeans. Mr.Slocum, Executive Vice President North Carolina Forestry Association, questioned Dr. Chameides about the positivity of active management of forestry and felt that Dr. Chameides had implied that it was a negative when it comes to climate. Dr Chameides responded that it depends on how the wood is used after is has been cut down. A regulatory agency would have to workout a detail analysis of the products themselves. Mr. Slocum brought up the delaying harvesting and how long. He felt that active management of the forests is the answer and that museum management; "look but don't touch" is not the answer. Dr. Chameides agreed and said the concept of sequestration of the forests is a management issue. So not plant the forest and walk away. Mr. Profeta said that we are on line with EPA and there are tools in place to help make project plans. Dr Chameides feels that there needs to be a time line, a plan for a project and go forward with it. Mr. Hopkins had a question what markets would Dr. Chameides advocate. Should there be a Local market, Global market, Regional Market and should the markets be distinguished as to their products. Dr. Chameides said that in general the size of the markets needs to be as large as possible. How you account for leakage is an economics point of view using objectives measures of elasticity of demand and elasticity of Price. You can calculate what will happen in demand as prices increase. In conclusion Dr. Chameides said the size of the market is key in principal and it should be an international market. Dr. George Everette said that in the working group Climate Action Plan process

looked at changes in greenhouse gas emissions verses the cost. He wanted to know if a scale could be charted from graph #2 in Dr. Chameides slide presentation to compare Vehicle mileage and look at a scale differential. Please refer to page 7 of Real and Verifiable Carbon Offsets.

Next on the agenda was a Discussion of Opportunities and Recommendations for Carbon Offset Projects in North Carolina's Agriculture and Forestry Sectors by William C. McDowell, III, Southern Forest Projects Manager Environmental Defense. Mr. McDowell entertained questions from the commission Representative and Co-Chair Harrison wanted to know if the 1.7 million tons for swine carbon emission was based on methane. The answer was yes, and she noted that methane is 20 times more potent than carbon greenhouse gases. She also wanted to know where we stand on the Farm Bill SB 1465. Mr. McDowell said that there is funding for offsets and a renewable energy component that could help landowners get projects started. Mr. Profeta added that the question now is there going to be a new farm bill. There is a large amount of funding for the Bio Energy Bill but it failed in the Senate. Dr.Cecich asked if the Bio Energy project is complimentary to agriculture off sets or do they have a negative effect. Mr. McDowell said that it depends on the projects. Methane is 20% more times potent than carbon. It also depends on the differential standards, some have neutral benefits and others can have net carbon benefits and there are negative effects in some activities. Dr. Smith, referring to SB 1465, wanted to know the significant impact of methane on the atmosphere. He asked if we are on a pathway to catch methane emissions in North Carolina. Mr. McDowell said that there is a need for anti aggression on methane such as hog farms. The hog farms have attracted a lot of investors to capture methane. Mr. McDowell recommended for the commission to be more aggressive in finding funding by working economically and Jane Pryor said there needs to be more investment made in Hog Lagoons. More money should be appropriated to this cause. Senator Pittenger informed the commission of an Article in the Wall Street Journal concerning the conversion of methane and other biogases being studied by major High Tech Firms and Capitol Ventures. George Givens, Counsel for the commission elaborated on SB 1425 and SB 3. According to Mr. Givens the big Energy Bill SB 3 provided for finding ways and appropriately set a side for the generation of renewable energy some of which would undoubtley would accumulate methane through capture. Senate Bill 1465 has a lagoon conversion program that is funded through the agriculture program and through appropriation. It also has a provision for a pilot program on methane capture that capted a max of fifty farms and has a max of 24 mega watts. That has a duration of about seven years that is paid for by a surcharge on rate payers and when you're talking about how you are going to fund these things, it is a matter of considerable negotiations and political sensitivity.

Co-Chair Harrison introduced Mr. Brock M. Nicholson, Deputy Director, Division of Air Quality, DENR, for a presentation and consideration of the recommendations of the Agriculture, Forestry, and Waste Technical Working Group of the Climate Action Plan Advisory Group. Before Mr. Nicholson, Mr. Givins was recognized to address the agenda. In regard to this agenda item he brought to the commission's attention a memo from the Center of Climate Strategies regarding the technical and economic qualifications as received for information and asked that it be put in the record. See Attachment The Center for Climate Strategies dated December 3, 2007, Subject: Center for Climate Strategies Technical and Economic Qualifications. Mr. Brock's opening remarks explained that the CAPAG group was made up of many NC Volunteers, stake overs, and members of this commission. The recommendations that will be the focus of the meeting will be from the Agriculture, Forestry and Waste Areas which are from five working groups or Twig working groups. The recommendations received unanimous consensus from the CAPAG after initial deliberations in the working groups. Mr. Brock said that his presentation would introduce to the commission some thoughts or suggestions by this group and that regarding the course of action that the commission and policy makers in this state might make from this point forward to realize implementation of these recommendations. Mr. Brock, next, began a slide show presentation. See Attachment: DAQ Suggestions for Course of Action on CAPAG AFW Recommendations. The basic criterion that Mr. Nicholson used in suggesting these recommendations is

the certainty of whether or not there were savings or costs net up front costs in this analysis and specifically in the CAPAG analysis. The recommendations, particularly those calling for legislative action is suggested because the CAPAG analysis suggest that there may not be an up front savings net of cost, but long term maybe there would be savings in economic benefits and that would be very positive especially in Jobs. There would be the opportunity to create a whole series of jobs in the process. The idea that there is the need for the Legislature to be involved is because there are complex social questions and should be dealt with by the highest level of policy making in the state which is the legislature. See Attachment: Appendix H of the Draft Mitigation Options for Controlling Greenhhouse Gas Emissions which elaborates and explains at length each recommendation presented in the slide presentation.

Thomas Peterson, President and CEO, Center for Climate Strategies and Stephen Roe, Senior Scientist, E.H. Pechan and Associates and Facilitator, Agriculture, Forestry, and Waste Management Technical Work Group and Lead Consultant for Emissions Inventory, Center for Climate Strategies, Dennis W. Hazel, Assistant Professor and Extension Specialist Department of Forestry and Environmental Resources, NCSU,Christopher B. Hopkins, Outreach Associate, Department of Forestry and Environmental Resources, NCSU, M. Paul Sherman, Director of Air Quality and Energy Programs, North Carolina Farm Bureau Foundation and Robert W. Slocum, Jr., Executive Vice President North Carolina Forestry Association were next on the agenda to elaborate on the recommendations, lead discussions and answer questions.

Mr. Peterson introduces Steve Roe who will walk the committee through each of the recommendations on Agriculture, Forestry and waste made by CAPAG. Mr. Roe was the leader of the technical work group. and will show the intent and structure of the options. Mr. Peterson also asked that Bob, Paul, Dennis and Chris to elaborate and be involved in Q and A regarding the individual recommendations. Mr. Peterson noted that the consideration of these recommendations included economic opportunities through market base systems, which included offset opportunities. Considerations of these actions were not limited to their potential as offsets in a credit market either. There are much broader and intergrated opportunities for these actions to move forward and create economic opportunities and emission reductions in NC. So the group looked at a broad net of potential approaches that would be appropriate and sensible as they structured the options and the listing of them is in table form in the beginning of the Chapter of CAPAG on Agriculture, Forestry and Waste Technical Working Group Recommendations. See Attached Appendix H. Each recommendation has a write up that has a dozen elements that were specifically taking in the design and analysis of the options is summarized in the report.

Mr. Roe presents slides to the members. See Attachment DAQ Suggestions for Course of Action on CAPAG AFW Recommendations which is an outline of the recommendations in Appendix H. Steve told the members the costs net end up with a cost savings. He said that the over all costs ended up in a wash. He also said that all the recommendations received a unanimous report and that there were no objections from CAPAG.

Next Mr. Peterson asked that Stephen, Dennis, Paul or Bob elaborate on each option and take questions from the members. Paul spoke on option AFW-1, Manure Digesters and Energy Utilization. He said the cost figures used in this opinion was based on a lot of a NC data project especially dealing with swine. It was a project that doesn't fit in a nice category as where current regulation of swine waste didn't quite meet the now current regulations for a new Lagoon not costs based on a project that just catches methane and doesn't actually look at additional treatment. Most of the costs were based on the Barum Farm project. Steve said that the group used the Barum Farm project that was done in North Carolina which served as the base for the information that the group looked at the Hog Farm. The work group felt that it was good for NC specifically a bit conservative on the cost side as compared to other costs that we are seeing nationally and coming out of projects of projects in other states. Paul added that in his opinion that

the status of swine waste to the electricity to the set asides in Senate Bill 3 is .2% of the electricity generated in the state. He said he was not sure where it falls in the goal that CAPAG has put forth. It is relatively close the CAPAG that we have here is a little higher than n the goal as to what the set aside in Senate Bill 3.

Co Chair Harrison asked is the reference in AFW60 to starch base ethanol corn? Paul answered yes, that basically it is mid-west corn based ethanol and is the predominate source of ethanol in the US today. Rep. Harrison said she had heard that there might be more greenhouse gases emissions associated with corn-based ethanol than associated in fossil fuel. She asked if the group was recommending the production or use of corn-based ethanol. Paul said that the group wanted to show that not only celulosic ethanol be looked at but wanted to show within the options and analysis the benefits of utilizing greenhouse superior, peat stocks and methods. Contemporary wisdom is centering around a slight benefit associated with corn-based ethanol on the order of 18% to 20% relative to gasoline. Celulsoic produces at least 80% benefit relative to gasoline.

Representative Harrison referred to AFW-4b and asked if the reference to the CAPG group is recommending that there be more preservation and production for biomass used for energy purposes can offset fossil fuel use. Was there some size range of tracts of land? She thought that we want to promote more forestry production and conservation as we can. Paul said that it bears some additional clarification. Under 4b we're really looking at to preserve a forest base under 4b so that we aren't losing any more ground, while other options including AFW-9 and 10, we are looking to increasing the level of productivity within the existing forest base. So if there is really no conflict that he sees. His doesn't know of any conflict in the preservation. Bob's concern is that more to do with terminology than anything else. When you say preservation keep in mind that automatically congers up the museum management- take these lands and set them aside and don't touch them- and that's not maintaining the forest base. Regarding size limit, there is no question that management gets smaller. Management options as ownership gets smaller management and management gets more difficult and more expensive. When you get below 10 acres is difficult and you have tremendous costs verses the small acreage and it makes some of these operations more difficult according to Bob Slocum.

Paul asked if there were more questions on AFW 1 and Ivan Urland had a clarifying question on under related programs Federal renewal energy production tax credits and then as it explains the cost analysis and what factors were included. It says renewable energy production census was not included but it could have a small effect on estimated cost. Did the group not include the Federal and did the group not include the State renewable energy tax credits. Paul answered: We did not include the Federal, Are you referring to the energy per kilowatt per hour tax credit? Urland was. That was the one that Paul discussed with the Ag Star program. He said that they were not sure how likely that was going to be available to us within the policy period. On the state side we exclude those with in the CAPAG process not just within our options but across all the other work groups because they are considered to be in state costs. We do take the Federal grant program into consideration.

Questions were put on hold for Dr. Crawford Brown to make a statement. We have thirteen policies that give us 3 % production in CO2 emissions. Am I doing the math right. Seems like an awful lot of policies for a tiny, tiny reduction that 8 million people in NC each with 25 metric tons comes out to be 200 million people in NC each with 25 metric tons- He then with draws this question and goes back to the question regarding the scope and benefit. The scope of these I think and what benefit do you get and if you look down these lists and this is the 1st one (AW1) I urge you as you go through this list of policies in each area there is a cost effectiveness and there's a tons reduce some of which show negative numbers which means savings and certainly we ought to encourage all of those. But when you get to recommendations that have cost per ton that are very high verses the benefit you have to question why they are on the list. I question

that process even though it says unanimous consent but without having all of these in one package rather than in individual categories, That's very difficult to do, but what would be helpful to have a pie diagram that says "here's the source of CO2 emissions per metric tons of carbon emitted from each section and then what these strategies do in cost and the reduction you get. You can do that with this report. It takes a lot of effort but I think it is important to look at that cost effectiveness test and the total emissions reduced out in 20-20 as a result of each those steps that what is very valuable.

Co Chair Harrison asks M. Peterson if he could provide a chart to the commission at the next meeting so that they could put all of this in perspective. Mr. Peterson answered Absolutely. Rep Harrison said that our hope today was to prioritize some of these suggestions. We will go through these items line by line then we'll discuss the merits of the.

The meeting was then turned over to Tom for further discussion. Mr. Profeta had a question. In the 1st two witnesses, I found some good recommendations in terms of how to seize the offset opportunity in terms of extension services educating landowners trying to create standards. Is there any place that we can fit those into this? Or would it be a thing of a separate of recommendations that would be educate land owners and create the standard encouraging investment and does that fit within the concept, should we have our own addendum. How do three recommendations fit in the thirteen.

Tom Peterson: Maybe a slightly way to frame that there are three general principals or approaches that are behind the engineering of most of these actions. One is to create more or some policy driven opportunity or need for reductions so it's really on the demand side to try to create that and to the extent possible and some market driven or market base manner. But also at a policy base manner, secondly to create or enable a supply response to put in place mechanisms whether it is financial assistance standards, education, etc. It would create or enable some response, some supply of the reductions that would meet that demand. And the third is to bring as much flexibility to that as possible so that the transition to going forward to those new actions will best be suited to the markets and parties involved in implementation, creation of demand, creation of supply of flexibility that really are behind all of these and it depends one by one on exactly what levers and mechanisms need to be put in place to do any one of those three pieces.

Mr. Profeta: What is the government's ability to grasp opportunities that are on this chart before us. I think about – well if this commission is going to recommend the policies proposal, we have to think about what is the overlaying government intervention programs, etc. I hope we will grasp the opportunities.

Tom's response to a previous question. 25% of total reductions of the action recommended by the CAPAG are from this particular batch of 13. Mr. Profeta says he wants the Big Hit. He wants 60%. He doesn't want so many policies. He wants a small number of highly effective policies.

Tom Peterson: What was considered by the group in identifying these actions was not only ones that had sheer emission reductions potential but ones that for other reasons might none the less be important to the State, certainly there's an issue of co benefits. It's also to be fair a little bit that some of the recommendations don't look, during this time period, like they are big performers, but in longer time frames, they could be important stage setting to reductions down stream. So there were a variety of considerations going into the list, and demonstrate graphically how that all plays out.

The commission moved next to AFW2, Biodiesel Production (incentives for feedstocks and production plants). Co chair Harrison asked if anyone had any thing to add to Steve's description. There were no additions or questions. Next was AFW 3 Soil Carbon Management (including organic production methods incentives). Bob Slocum had one comment to make: There was a reference in our discussion to Celulosic Ethanol. AFW 4a (Preservation of Working Land – Agriculture Land and AFW – 4b

Preservation of Working Land – Forest Land were now up for discussion. Representative Harrison had a question on Present Use value: Did you all talk about some of the existing centers, the way our Present Use Value is structured? Were you specific in that? The answer was yes there was discussion of Present Use value and Bob Slocum had quite a bit to say on, is there anything that you would like to bring out Bob? Bob: not really there are growing programs that have served landowners very well. – good stimulus to improve actively managed forestland, which is Critical to the landowners. Another answer was that there is some discussion of land use value in AFW 4a and 4b and the reason for that is we just wanted to emphasize the fact that they have shown themselves to be effective programs and want to make sure that they continue.

Dr. Eggers had a question about non working forests and what are the current policies in either of these – just incentives for maintaining land in non working, non economic short term sense? Rep. Harrison said: There are incentives set-ups and the Legislature is working on that. Lands managed for wildlife and conservation. We have some legislation that passed the house last session that's been referred to the Senate – It would allow for different categories for Present Use Value, but it didn't want to actively cultivate your timber but one that set it up for wildlife management, or conservation which provided a new category of Present Use Value and there are others that we have been addressing some in the Legislature.

Bob Slocum: The resistance to that approach comes from the counties early and you probably know this as well as I do, it is the counties that are losing a revenue source if the lands are working in the sense of generating revenue. The counties can be upset of losing that source of taxable revenue. Rep. Harrison says this is accurate. Another question was: There lots of reasons to preserve agriculture, but perhaps from a cost benefit analysis; carbon reduction is not one of them. Did you consider just to remove this recommendation because it is tail wagging is all.

Paul: Great point because it is really tough with in one table to show all of the benefits that might be achieved – carbon or otherwise. As you mentioned I think we do address non carbon benefits within the write up in the policy but it is somewhat misleading to look at only these greenhouse gas reductions related number that you see on the chart, 4a.

Tom Peterson: I think you raise an important point. I think some of the recommendations on this list were actions that the group believed were likely to move forward for reasons other than carbon management, but could be tweaked a bit to try to be as carbon friendly as possible, and in any event, the concern was to try to make sure that we could score out the benefits of those programs as they move forward whether they are enhanced or not. So we've got a record of the benefit associated with it so you are seeing some reflection of that in this on list.

Paul: A lot more of that is that it speaks to cross cutting benefits for some of these that are captured in other areas that haven't been discussed, yet specifically with this one you have some of the transportation and land use options that deal with reducing vehicle miles traveled and part of that is preserving working lands. It's fits in as a small part of the whole. When we break them out in tables like this, they sort of lose a little bit of the focus on some of the larger items.

Bob Slocum: On working lands where we said that we've lost these acres to development and lack of post harvest regeneration it implies that the lack of regeneration equates to the loss of forests land and it doesn't. Simply the lack of post harvest regeneration (intentional act of a land owner) does not equate to the loss of forest lands, in fact, the only way you're going to lose the forest land is if you put a concrete slab on it or pave it over. Nature will take care of it one way or another; it may not be as productive as if a landowner had intentionally re-forested it under a management plan. The other, with regards to forestry,

it's important to understand the what land out there from a forestry standpoint is very aggressive and it's going to require to achieve these benefits and is going to require an unprecedented level of up front costs. An investment somebody is going to have to front a whole lot of money for these things to actually be realized. And from the standpoint of carbon, the benefits are accrued over a long period of time. It's not a one to one immediate benefit. There's a lot of other reasons to do this that make great sense - economically and environmentally. Understand there are some significant up front costs that are going to be necessary to achieve these things.

Paul: I might add that the mobilization of capital is certainly a big issue that turns up in many different place. Bob you raised a very important technical point. I think we want to double check that, and correct me if I'm wrong, but the numbers that were used in terms of the base line and projected conversion rates for changes for forest – cover are from the Natural Resource Inventory NRIUSDA – those are specifically land cover conversions to develop uses which have a technical definition. Those are not land cover changes that are associated with the removal of trees that can be regenerated whether natural or otherwise at whatever level. So that's a different category and so we want to make sure haven't mixed those numbers. On another issue, I think that what comes up is that we need to reinterate the semantics, terminology working lands implication here as these lands are retained in forest cover. That is not to imply that there will be a removal of management practices on the land. Soot the intent was clearly that these could be maintained in some appropriate form of activity management consistent with carbon friendly practices. Did I get that right? Yes

Dennis tells those on the commission that they will get a complete presentation from CAPAG – The social feasible noted in the back of the Appendix. Those of you who are going to be pouring over, I guess, each of the results from all five of these work groups presumably you are going to get the complete presentation from the CAPAG. As we proceeded we noted and were aware and discussed things like fiscal feasibility or social feasibility and they are noted usually in the back of each of the policy options presented. So obviously we don't discuss everything in detail, but they are noted and considerations that are discussed. And also with respect to the forestry options 4b and 8, 9, and 10 that we'll get to and in each or those cases the policy options are largely designed around already demonstrated successful programs of some kind that are either in place or their designed to be like another program that's in place and already working.

Paul: Thank you Dennis and yes the Appendix to the report which is on the website (un audible) is long and has additional references. It has more information and we can provide that.

The Co-chair asks if there is any elaboration on AFW 5 Agriculture Biomass Feedstocks for Electricity of Steam Production. Dennis responds: I would just note again that this one runs pretty well in tandem with Senate Bill 3, and that pretty much addresses the recommendation fairly we.

AFW6 Policies to Promote Ethanol Production is now up for discussion. Chris Hopkins: Along with the other clarifications on technology assumptions I do want to add to this one is that this is also a pretty aggressive set of goals here. I think we didn't quite realize how aggressive it was when we started out. I think people had a feeling that it was, but once we started looking a little bit more at the feasibility and the availability of feed stocks to produce this much celulosic ethanol we found we're starting to but up against the ceiling of what might be available. So I think we noted the need for additional research into feed stock availability, but I think we are really approaching the upper limits of the benefit that could be achieved through this option again in tandem with TOU 7.

Steve explained that AFW 7 was moved to AFW 4b and AFW 8 Afforestation and/or Restoration of Non-forested Lands would the next option to discuss.

Dennis Hazel: My only comment would be that in response to George Everette that as you look through the cost effectiveness of each of these items, for instance nine and ten has the negative number because of the positive benefits of producing forests products and what it does within the economy. For AFW 8 there is none of that because we're talking about establishing new lands. Forest products will not be produced until a time frame beyond the scope of this analysis. These are all new stands.

AFW 9 & 10 Expanded Use of Forest Biomass and Better Forest Management. Dennis: Just a comment on the number that was given when Steve Roe was doing the presentation of $9.00 per acre for these costs. There is no practice that I'm aware of that we can implement on a tract of forestland for $9.00. That is a number that in economic terms is an annualize present value of all practices applied during the life of the stand so it's a way of allowing us to do the analysis. But we recognize that doesn't represent the cost of treating an acre of land with any particular practice. Dennis asks if that's a cost per ton of carbon saved. I think it is the metric that we have up here so its not the cost per acre it is an in put to that calculation. That's a separate calculation. Steve he did mention in puts to that cost and that he did mention $9.00 per acre annualized over all of the treatments that would be used.

Speaker's name not audible: I think on this one, I heard concern from the environmental community about the risk that some of this waste biomass currently provides some habitat for species after timbering is done and that it protects against erosion in areas where the grade is steeper. Can someone comment on whether this is a concern and whether that has been addressed in anyway?

Paul: Most of this discussion concerning this has occurred in context of the newable port standard and we've been in discussions with Environmental Defense. We talked about what would be a reasonable amount of biomass to leave on the landscape. We have general agreement that some snags and some wildlife brush piles would be feasible, relatively easy to accomplish and without any real impact to the total biomass available for energy production. Probably the largest cause of concern that remains would be the widely dispersed coarse weed debris section – what could we leave in terms of coarse weed degree widely dispersed. It's an open question as to what wildlife actually needs. We have, as far as erosion concerns go, we have four (inaudible) acts that should cover any wide scale erosion of soil into the streams and that's not al0oawed in any case biomass harvest or not. The outstanding issue is what coarse weed debris is needed by wildlife and the best we can tell is no definitive answer in the research as exists now. Nobody knows yet the need for that specific species or class of species or type of life form. So this is an open question and one that really does need some research.

Follow Up: I think would wildlife once the forest is removed being the critical habitat then, some of this becomes irrelevant. Just because we don't know wildlife and habitat needs. We know that they are non-zero. I have some concern about the same thing and it's more related to soil and soil management. Through research, I'm familiar within the Specific North West and in British Columbia that has to do mycelium inoculation of the material left on the ground and beneficial enhancement of soil and actually the significantly improvement rate of reforestation and carbon sequestration. I think the recommendations to increase the removable biomass from large areas is moving in the wrong direction for several reasons and it's not all clear to me from a climate perspective it's compelling in any way.

Paul: First of all the biomass- what would we do with the biomass – that's the question and the primary use of that biomass that would be removed is to off set co-combustion... Either use reuse carbon that's already in the eco system in the biosphere or we can use carbon that 's coming geologic sources. One has that life cycle of a year many tens of hundreds of years of life cycle. So we're basically reusing carbon that's already in the biosphere as opposed as to the stuff that is in the geological cycle. No wasn't part of our discussions. The actual – one of the critical habitats needs for wildlife in the State is early sucessional

forests, Typically tropical migrant sector, that group of species.. Early successional comes from harvesting stands that have been (in audible) numerous times. So there are some real wildlife benefits to the harvesting.

Follow up: Yet my comment was not about harvesting at all. It was about the Biomass on the ground So you can just be focusing on that, I agree with what you are saying but I think another aspect of it is obviously the issue is not just as simple as co-off setting with wood but that is we decrease the rate of carbon sequestration of the forest that replaces the forest that was cut down, Then we might not really be gaining. This needs to be thought about.

Chris: And one of the arguments is to increase the fertility and the overall carbon sequestration rate of these forests. We can do that in several ways. 1. Increase the fertility of the sites. Fertilization can get you somewhere between 60 and 80% increases in fertility of the sites and that includes low ground and above ground. 2. Concentrating on growth on larger trees which produce larger products which have a much higher durability. 3. We're taking biomass and we are offsetting coal. Good reasons to consider doing much more aggression toward forest harvesting and forest management.

Follow up: I think actually considering the effects and think we should consider using synthetic fertilizers and we don't have the run off problems and we don't have the nitrogen and phosphorus problems in our surface waters, etc., etc. Nor do we have sedimentation problems which while we have regulations in place to protect our surface waters we know sedimentation is the biggest problem and some of that comes (un audible) I don't support this as written.

Bob: I guess I would caution about trying to look at this particular option too narrowly and just focus on the so-called Bio fuels aspect. Economics is going to drive Bio fuels and I tell you right now even if you gave wood away the economics of simply moving from point A to B make it non competitive. So how much of this stuff is actually used for Bio fuels – follow the money- will tell you and how much is actually there is in pure logging residue. I've got a fair number people in my associations that actually question how much really buyable material is going unused now. I think the Bio fuels side of it maybe driven by pre-commercial finning and some are bad in using some standing timber as opposed to the residues. I think a lot of foresters share the concern about long term impacts on soil fertility, but what I think this option really does speak to is improving the use expanding use of wood products in general which when it comes to carbon, certainly is superior to concrete and steel. And I caution, don't just get caught up in the Bio fuels aspect. This is a lot broader.

Co Chair Harrison: I want to point out a concern that we had about wood in regard to the biomass issue for energy is the environmental impact of the emissions and we heard a discussion during the Senate Bill 3 about how it was actually dirtier that coal and that the (un audible) will help us develop some recommendations to get at that.

Paul: Any further discussion and 9 and 10?

George Givins. Bob Slocum did use and is correct especially with this option about this being an unprecedented size program. It's built around cost sharing. Now we just mentioned that with this option, as many others, it's not necessarily an all or nothing If it seems wise to do a portion of it, then you get the corresponding benefit and it is recognized that this would be an enormous unprecedented wrap up, particularly in place sharing program. I would add landowners do respond to cost sharing programs real favorably and when money is allocated it gets used.

Question for Chris: As you were going through the list of things that were considered, I didn't hear methane from forest residue left in place or if it just degrades.

Chris: I think methane is only produced an optic environment. You don't get large amounts of methane from forest residues unless you've got them covered over with old landfills or water. So I don't think methane is necessarily an issue with forests residues. They tend to be pretty well air rated

AFW 11 Landfill Methane and Biogas Energy Programs. Name of speaker (inaudible) where in the process did we look at solid waste incinerators?

Tom: That was not something that we looked at in this process. In both the waste management options, the first is pretty narrowly defined in making sure that we're capturing more landfill methane. Second one is really just focused on increasing recycling rates.

Follow up: Was that perhaps captured in another sub-group? Solid waste incinerators and it's impact

Tom: No, I think within our original catalog of options that we looked at waste to energy is one of those, it just was not one that the overall work group felt inclined to bring into our initial list of priorities which you are seeing here.

AFW 12 Increased Recycling Infrastructure and Collection. Representative Underhill was recognized: I just feel like this particular piece in AFW we that we need to look at and examine how other states ahead of us or behind us. Because when ever I ask people about their local recycling opportunities, everyone seems to want to do it but the local agencies are just not making that possible and a lot of the things on your list are very, very significant when a narrow number of people are involved with them. The recycling program is a place where the public can buy in and feel like they are at least doing something to help lower carbon emissions in their own wan and I think it's important to have a fairly simple piece that everyone's always throwing up that it's too expensive. I just don't think we can ignore recycling as a motivational tool in our state. The litter problem that we have is incredibly difficult. I'm glad this is on here.

AFW 13 Urban Forestry Measures Mr. Hopkins makes a statement: Looking over the numbers and taking in the earlier discussions about the overall table 6 – the two largest benefits are in terms of negative net present value are 9 and 10 and 13 and I think just looking over some of the assumptions in 13, I probably challenge whether that's an achievable number in terms of over all reductions, savings and (un audible) I will probably address them on line or I will say there is a typo on page H 63 of Appendix H where cooling cost not winter cost in the summer.

Representative Allen: What parts of our state have urban forests. Chris: we don't have an actual number for what you would call urban forests. We can tell you pretty clearly what the forestland cover of the state is. How that intersects with what you would call urban because urban forests can be not only be a tree cover around a house, but a park, a lot of urban parks can qualify as forested. Speaker not identified: One of the things this recommendation makes me think of is there are a lot of community based organizations in NC assessing solar resource in the residential sector for the use of solar power. While it is a great thing to be planting more trees, there seems to be there could be a refinement of this recommendation you don't absolutely have to plant three more trees on a property where it is going to eliminate your ability to use solar hot water and solar electric, If this recommendation could be cognizant of that and try to recommend a balanced approach so that a very concerned land owner could utilize both solutions.

Paul asked for any additional questions or comments on AFW 13 being none Tom closed the discussion.

Tom: In conclusion, I would just add that kind of more broadly a reminder that the numbers that you see on the screen in front of you- these are what we call stand alone numbers or the reduction potential on the costs of cost savings per ton of individual actions but when they're combined together not only within this work group area but with other sectors such as transportation, power generation etc. We pulled together agric numbers in terms of greenhouse emission potential and agric cost effectiveness for all of the CAPAG actions combined. It's significant because there are many integrated and interactive effects between the options, some of them were quite deliberate, others were not but have to be recognized quantatively in terms of deliberated integration. There are a number of measures that are (un audible) contain both supply side and demand side approaches that sit in different places, for instance, we see biofuels supply side issues residing here in Ag. Forestry and waste and the demand issues typically residing in transportation and land use but it is anticipated that the implementation of an overall plan would glue these together. There is a three components of that which would be to even bring additional flexibility to that which could be related to their marked base systems or measurement systems that insure crediting, etc.- that's picked up by the cross cutting issues work group. So I think while we're presenting these one by one and presenting just this work group it should be recognized this is a part of a larger integrated whole that came out of the process. The other point, just a reminder Chairman Garrou in response just to reinterate the point you made earlier- the numbers that we have up here in terms of the cost or cost savings are really the direct costs of implementation of this particular action. They don't include actuary benefits or costs to certainly the issue Co benefits is a significant one in many areas and that's documented elsewhere. These numbers also do not include thee secondary economic impact in terms of jobs, value added income that is the subject of the Appalachian State University study that's going on right now. That is additional secondary information that's not on the chart

Chairwoman Harrison: At this point we would like to take any additional comments and input from the commission.

Jane Preyer: Two things pop up to me today. After hearing all the comments today, one is what George Everette said at looking closely at the cost effectiveness combined with the green house reductions per time and combining those big boosts. Second one is some of the carbon offsets per discussion we heard and the opportunities potential the position NC to be more ready for this or to get in lead on this and get out front. So I would throw out that those are potentially two criteria to think about set of recommendations and the next step somehow getting more specific about some proposals that might feed on those criteria some way.

Dr. Smith: I agree with that. Is there a way just a way just looking at the way CCS has come up with their cost effectiveness? Some of the things that were presented here earlier about the offsets – is there a net present value type calculation that can actually be brought into the overall equation here so we can try to compare apples to apples and then someway – Has that already been done? Will you give us a sense of that or I think if we add that in, which I would encourage that we certainly take a look at, I think a lot of benefits would be interesting to do that.

Steve Roe: Just to underscore that the cost effectiveness numbers that we produced which are essentially direct costs per cost savings per ton are not necessarily the same as the transaction costs that might occur in the market, either for an offset or for a tradable credit because other things go into the termination of that price set up. Actually scrub it down to an offset price would take a little bit more analysis, but I think what you see is one of the most important inputs to that which is cost per across the series to get the marginal abatement actions.

Dr. Smith: Well I guess the question I have is do we want to try to have a discussion here about some agreed upon methodology prioritizing this? Because I think the other overlay to just be very frank about is you've got greenhouse gas reduction cost effectiveness and than you have this sort of politically reality constrained and I think those all have to be sort of factored in here if we're looking at how we take these from the paper and the process we've gone through to where they get in some from of implementation. So it would be interesting to have a discussion with it about how to prioritize these in some way and see if we can get some general agreement from the various members here about how we might do that and what that might look like.

Chairwoman Harrison: I think it's entirely pertinent that we have that discussion today. Do you have some input?

Paul Sherman: Just wanted to add a little bit of background as to what the Farm Bureau has been doing outside this process. We have had several state holder group meetings with various organizations and it sort of led us down the road of organizing several carbon trading work shops that we are going to have actually next week. To do some of the things that are recommended here mainly is the education piece is bringing in land owners whether it be farm or forest as well as co-operative extension in soil and water conservation, district folks, NRCS, educating them about what carbon credit or what carbon credit trading is, how it all comes about and even bring in currently one and maybe in the future multiple variations of the voluntary trading markets that are out there and ways that they can participate in those markets. And sort of something in the back of our mind is part of this process is we can certainly look at what's been done here in the CAPAG . But there are ways that some of the costs of these, some of this education is a whole lot lower cost as far as participating in markets that are already out there that you and see the benefits expect mental to the cost. As far as just helping to promote those types of things that steer up toward a goal without being too terribly forceful about it. With the mechanisms we have out there and then with the Federal mechanisms that are likely down the road.

Mr. Tobin: Madam Chair these recommendations have been developed over the last couple of years by a broad state holder group represented within the CAPAG. And It seems to me that given the presentation of those results the analysi8s that's been done on those items and relative lack of objection to the items that were presented today that we might be at a point where a motion could be made to have the commission adopt these recommendation and to begin the process of developing these items either individually or in some into a bill and it seems that we've got at least four other presentations of items of a similar complexity. And Those, I think it was hoped this is a point of order that Mr. Givens can clarify that some of those might be developed for 2008 session. And it looks to me like with maybe one or two exceptions on this list there is some consensus here that we have a good starting point from which to develop some legislation that could be considered by the General Assembly. So I would just submit that if the time is right, then perhaps a motion could be made and again Mr. Givens could (in audible) if this the time but to go ahead and see if the commission is ready to accept these recommendations made by the CAPAG. Several of whom are serving in both committees but to go ahead and get to the next stage which is a drafting stage where these specific points can be aired for a broader audience.

Chairwoman Harrison: Thank you. I'm going let Mr. Givens have first crack.

George Givens: Well let me at some risk, I will observe that the consensus in this or consensus within the CAPAG is not necessarily translated to consensus across the street or in this room which is populated by the Finance Committee, The Appropriations Committee, or whatever. I think that, well let me say this, I purposely didn't orchestrate some particular outcome to this meeting because I wanted to give you all an opportunity to discuss and how this would go. As a practical matter, I can tell you that (in audible) bills to

implement all 54 or 157, whatever the number is, we just don't have the resources to do that and the General Assembly s0 not have the resources, in time, I think particularly in the Short Session to give all those adequate consideration. Therefore I would encourage you to take observations that Mr. Everett has on cost effectiveness and then factor in there some estimation for reality and we as a staff would like to work on the ones that it appears have the best chance of going forward in 08. Now I would observe to you the following factors, you've got the LCAPAG recommendations as somebody just pointed out and saw some of this in the discussion of we had in February leading up to the Long Session. The recommendations in the CAPAG report are not the be all and end all. There are other ideas that people have that can be looked at. In addition to those issues there's the adaptation issue we're going to begin the discussion of that at the January meeting. There is the question of the goal and that question of the goal really, I thought we would, it was my intention that we have more discussion on that issue at this time. The fact that we haven't is our fault and we will try to remedy that next time. I don't start with presumption; the legislation doesn't start with a presumption that there should be a goal. It says we need to figure that out, but a goal is a guide to how you choose which of these measures you want to pursue. Beyond that there is the question, at least in my mind that the future of this commission is presently set to sunset. When I say this I don't mean this particular this group is appointed constituted but whether we do about Climate Change going forward, what we do about adaptation, what we do about additional mitigation measure. I have some ideas about that as I suspect many of you have some ideas about that. So I think at this point, probably what I would like to hear is if there's further discussion on these proposals in light of what might actually be politically do-able, one of the good features of this commission is that we have a broad in put from outside the legislature that comes at the expense of the fact that you have relatively few people like Senator Albertson, Representative Underhill and Representative Harrison who would have paid to get these bill shepherded through. I can tell you it's from my own experience of 20 some years in looking at the effort that went into Senate Bill e is controversial (in audible) effort hard for it to get one item through the Legislature. And so that's my gloss on it, in other words, I think to answer your question directly a motion to go out and do good, however commendable , is not particularly helpful at this point. We need something a little more surgical, and if we're not prepared to do that today then we need to figure out how we're going to get there. And I'm prepared to help you do that.

Mr. Garrou: One of the things that I think this commission needs to decide and this is a political question, I'm not sure in the Legislature so I don't know how to answer it. Do we really want to recommend 54 things or do we want recommend 3 things, 5 things? So I would suggest that we don't want to adopt all these things today, but we want to wait until we see the whole package and then say do we really want to recommend all these things or do we want to push a half a dozen of them.

Harrison: And I can just add to that when we issue our report we can still contain these recommendations and then we'll have specific goal proposals as well. So its not that these recommendations will be left out, if that helps at all.

Mr. Slocum: Yes, I think the (in audible) of Mr. Givens is well taken and when I look at the recommendations that are made in this group and are made in this section and then how do you get there now there are a few things that come to mind. Almost every one of them is a money issue that actually makes it happen and there are a couple established programs that really touch on or would get at several of these. The Agriculture and Farmland Preservation and Trust Fund gets some of this. The existing car share programs for forest and agriculture get at a large part of this. We've got Senate Bill 3 created a center for biofuels in NC which really gets at the biofuels section, so there may be some specific things that can be recommended that w3ould get us toward a large range of large number of these but it's a small number. The reality of how much more money is available. I leave that to the astute guidance of Senator Albertson, the chair, and Representative Underhill; but unfortunately to get to where we want to go or

where this report recommends, It's a money issue to a large degree and now where the money is going to come from.

Co-Chair Harrison: Thank you. Mr. Profeta

Mr. Profeta: Thank you madam chairman. I would agree with the comments of many of you in terms of trying to prioritize these recommendations. I think we've heard from George Everett we need to create some const effectiveness, bang for the buck criteria by which we are (inaudible). We want to ask for the chart and you certainly in ranking (in audible) I would say to Bob the reason I thought we might be able to pick up the three pieces that were in the McDowell testimony and because that's one way to facilitate some money not from the State but from private investment stream. And I think we seem to be fertile ground for that sort of investment and we probably should encourage to act fast, and encourage the investment stream to come. So when I hear Paul Sherman talking about we need more education for landowners – that's a piece of it, and when I hear Representative Thomas talk about we need a single standard that's a part of it. NC is on the board of the 40 State Climate Registry could advocate for one national standard on these offsets that would promote investment so I would suggest to the commission informally, not procedurally, is that we somehow ask for a cost effectiveness evaluation of CAPAG recommendations but also consider a package just to create the fertile investment environment and off sets.

Dr. Crawford: I do want to clarify my position. What I'm really much more interested in is that column which – what is the actual savings in CO 2 and what worries me about (inaudible) of this that having 50 recommendations is that each recommendation requires a champion that has to use their personal energy in chits and so forth to move things forward and I just think if we have a large number of these things each with small impact there's too much of a chance that at the end of the day a few of them go through and you end up with 8% drop in CO 2. I'd rather see bogus effort of a numbered people around e or 4 really big issues where at the end of the day we say boy did we make a big drop in the CO w emissions for the State

Mr. Urlaub: Thank you, following up on Douglas Brown's and George Everett's comments what I'm thinking is – could we have some kind of one pager that maps out the inner relationship of across the five sector groups. There was mention of several of these agriculture, forestry and waste management options that they're incremental above and beyond one or more other options and other categories and if we could have maps or word piece options where these options do naturally group together and where they're incremental to each other then we could maybe start to see a bigger picture where there's several options across sectors that could formulate into one agri-gret recommendation or policy action.

George Givens: I see Mr. Peterson nodding his head and I think that would be useful in a number of ways when you're looking at cost and cost benefits to get some across the board comparisons as opposed to just within individual sectors.

Tom Peterson: If I might just elaborate, it's fairly typical as a follow up phrase to the more detail line item planning recommendations to bundle actions phanatically or bundle them in a way that makes sense functionally in terms of implementation. So it would be very reasonable to expect that in terms of implementation, packages a list of 150 some will shrink (in audible) 10 or less in terms of structuring implementation programs and I would certainly anticipate that that's something that could be done as a next step here to integrate just as you suggest . The other thing I would just note is with respect to the cost effectiveness numbers, it will probably not be too long before we could add to these direct cost numbers the results of the Appalachian State Study which would indicate the potential benefits these actions might have in terms of jobs, income in value added that could be considered as a part of quote

unquote "band for the buck" calculation so is the commission would be interested in seeing those results added to have a bit broader picture in terms of economic opportunity that could be done as well.

Harrison: I think we would, I think that we would appreciate that. Thank You.

Dr. Eggers: Because we're having this discussion it seems like we're starting to kind of identify more of a triple bottom line issue that it's not just simple economic analyses, we have not simple in terms of effort but we need additional economic information and then major social impact that'll happen because of jobs and the major social impacts that will happen because of quality of life issues that will be affected by this for future generation and environmental impacts and so I would encourage us to because of the profound ethical obligation of this commission to consider all three of those bottom lines.

Harrison: Thank for that point.

Dr. Everett: Tom, I know that the draft final report says do note quote or cite. But we've all at least a large portion of us have seen it and in that at least in my October 16th version, I don't know which version we're on. There is a ranking that you've already done which would be helpful. I think to everybody when you're at a point when you're ready to share it. And the good news I would say about that ranking is in terms of reductions of emissions the number one item by far in the graph is done. So feel good about where we are. The next item on the list achieves about half of what item one does in terms of reduction of emissions and in terms the next table which is figure 1-4, it is I think very instructive to look over there on the far right hand side of that chart which is a ranking of dollars by ton and you'll see maybe where you can quickly begin to not worry about some of these items and they'll fall off pretty quickly so I think it does bring value to look at the whole set land not to take one of these working groups and do the whole package. We ought to selectively go through them just like this has attempted to do and it's very helpful to look at those charts. They're not definitive by themselves but they're helpful.

Dr. Smith: Well I don't disagree with that at all, I think ;that if we were, We should reach, I guess, some sort of agreement about how we want to go forward on this and what are going to be the methodologies if we're going to attempt to rank them try to drill down some very specific items. I do want to caution, although. I'm very aware of the political realities of the cost of going forward. I want people to remember because we haven't engaged in this discussion at the level that I think ultimately we're going to need to engage in it but there is a cost in-action and I think people have got to constantly remember that when we get into the adaptation and some of the things that the State is facing and some of the things, it's very easy to immediately look at the cost that you're dealing with and real time but I have to think we don't have, I think, fully the understanding of all the potential costs of in-action which may be able to shift that the political possibility equation. When we begin to really look at some of the costs that NC is going to surely incur from the need for adaptation and some of the things are in motion. So I just and I don't know how we are going to qualify that, and bring that in ultimately, but I think it's got to be part of overall calculus here because the financial political realities we are in today are not going be the same that we're going to be in the not too distant future. As these manifestations continue to unfold and for those of us who are dealing with issues like drought, this past year and other things like that and see some of the emerging issues that continue to sort of come at us very rapidly, I think it would be a mistake to only be looking at it in the context of sort of a politically reality and financial reality today because doing nothing on some of these issues is not an option. We're going end up paying one way or the other.

Co Chair Harrison: Very good point, thank you for that. Anybody else? I guess if there's nobody else who has anything to say, we'll adjourn. Thank you all for coming and our next----Mr. Profeta.

Tim Profeta: I'm sorry Madam Chair. Are there any other analyses like that George has describes that would be useful for our assessments. I think we should ask that question or I can just leave the question out there to be banged around with staff, but I, it strikes me if that analyses exists, I would like to see it and any similar, I would like to see them as will.

Harrison: And that analyses he references is in the summary document that we got last time and is on page I.17 summary to the CAPAG and we will redistribute that.

Profeta: Well I have that. So maybe the answer is no there are no others.

Harrison: But I will let Mr.Givens respond in more detail.

George Givens: Well what I was going to do is follow what Doug Brown said about the companions and the fact or the matter is that there are only some number of people to handle the bill regardless of how many recommendations you've got. And it would service commission's legacy well to propose six and get five than to propose 57 and get 4. What I think what we'll do is have some further discussion off line in addition to all the criteria that have been mentioned, the ones Dr. Everett and Dr. Eggers mentioned the political realities. I value most highly those suggestions that meet all those criteria and that there's always some draft legislation to use as a guide and we'll be looking for those and for those of you who have good samples that you've acquired from some place or other, we should be happy to have staff to see those and we'll be talking with many of you off line as to how to resolve the questions and issues we've raised today.

Harrison: Any thing else? I hope on the addition adaptation, if we bring up any of these other subject areas we're discussing, we will let you know in enough time so that you can review your document that we got at the last meeting or get the section out to you. So I guess with no further business, we'll adjourn. Thank you all for coming.

Respectfully Submitted

Representative Harrison

Anne Misenheimer
Committee Clerk

APPENDICES

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DRAFT

Global Climate Change Commission Meeting
Wednesday, January 16, 2008
10:00 a.m.
Room 643 LOB

The Legislative Commission on Global Climate Change met on Wednesday, January 16th in Room 643 of the Legislative Office Building with Representative Pricey Harrison, Co-Chair, Mr. Garrou, presiding. Other members present were: Sen. Albertson, Sen. Cowell, Sen. Pittenger, Rep. Allen, Rep. Underhill, Rep. Wilkins, Mr. Clark, Dr. Eggers, Mr. Tim Toben, Mr. Urlaub, Mr. Robert Glaser, Ms. Tompkins, Ms. Choi, Mr. Everett, Mr. Howard, Mr. Nelson, Mr. Peele, Mr. Profeta, Dr. Riggs, Ms. Preyer, Mr. Slocum, Dr. Smith, Mr. Stephenson, and Mr. Ebert.

Mr. Garrou called the meeting to order to order and asked Mr. Givens for remarks or explanation of the agenda items.

Mr. Givens: Thank you Mr. Chairman I have a number of things to discuss with you this morning. First of all I encourage all the members to sign the reimbursement forms and send them up to the clerks. For the visitors in the back, I encourage and ask you to sign the visitor's registration sheet (**Exhibit A**) which is on a clip board back there somewhere. With regards to some things that you need to know regarding the February meeting which will be held in connection with the Emerging Issues Forum and the focus of that forum is on energy and that will be February 11th and 12th. You have at your place an invitation (**Exhibit B**) from the Forum as well as a one page sheet to tell you how to register. If you are a member of the Legislature, your registration fee is comped by the form. If you are not a member of the legislature, then you will need to pay the registration fee for government officials and that will be reimbursable with a receipt in connection with your request for reimbursement for attendance of the February meeting. I don't want to pay for registration fees for people who don't want to attend. So I encourage you to be thoughtful about it, this is the February meeting and so I hope you will be able to attend both days, registration fee for government officials is $200 and again that is reimbursable. My concern is that the form registration will close when they receive their maximum projected attendance for enrollment. They indicate that will occur this week. You can register online, now I make this invitation in particular to members of the Commission because it is our February meeting but this forum is open to any one in the public and if you're back there in the back and would like a copy of the invitation we have plenty to hand out to you. Now there will be a business meeting of this Commission in connection with the forum. That is the only part of the forum that you don't have to register or pay a fee to attend. If the only thing you are going to do is come to the meeting of the Commission, you do not have to register. Because it is a public meeting it will be accessible to folks who don't have the badge to attend any of the forum events. That business

meeting will be held from 2:30 – 3:45 in Room 2 at the McKimmon Center. The purpose of that meeting is to hear from the chairman of the International Panel on Climate Change, Dr. Pachauri. This is I think a major accomplishment for this Commission. Dr. Pachauri is a Nobel Laureate this year for his work on climate change and the way this is going to work is this: there is an agenda item on the agenda today, agenda item 6 which will be Commissioner Eggers who will outline for us the most recent report from the International Panel on Climate Change. That is by way of preparation for the February meeting and we are doing it this way for this reason. We will have our meeting and we will have Dr. Pachauri with us before he addresses the forum, he actually addresses the forum at 4:00. Ideally he would address the forum and then we would have our meeting and we could have a question and answer session but we could not schedule that. So the thought process here is that today you will get an introduction to the most recent report of the IPCC. I hope that at any point doing that discussion or any point after this meeting if you had any thoughts about questions that you would like Dr. Pachauri to address or issues you would like for him to explore in particular when he meets with us, if you will let me know, I will communicate that to him. I am not communicating with him directly but with three first persons, but the invitation is out there. We want to make the best possible use of the hour that we have with him. So we are going to prepare for that today. Please plan on attending that whether or not you plan to attend any other part of the forum. If you don't plan to attend any other part of the forum you do not have to register and you do not have to pay the registration fee. If you wish to attend any part of the forum, you do need to register and that is either comped or reimbursable, there is a little wrinkle on the comped for a couple of people I'll be around to see you individually. There is a dinner Monday night for invited guest to the forum and all of you who are members of this Commission fall into that category. They are supposed to send me a letter which I will forward to you if you are going to attend the forum you should plan on joining us for dinner Monday evening. I will do my best to answer any additional questions. We have a handout for you which comes from NC State Alumni magazine (**Exhibit C**) and in it a brief article about Dr. Pachauri, his picture is on the cover and it's a question and answer interview type format.

It will be necessary for various logistical reasons to reschedule the April meeting. I am hopeful that we will have a proposed date later in this meeting. We are doing some checking right now, once the co-chairs and counsel have agreed upon an option of dates we are basically looking at the week following the week we have scheduled. We will try to put that out there and I would be interested to know if there are conflicts. You can be checking your calendars and thinking about that. We are going to try to settle among ourselves up here on the week of April 21st. I regret it is necessary to reschedule but it is.

There will be various handouts during the day I know Sen. Pittenger has something he wants distributed and he will undoubtedly hand it up here to us so we read it into record and distribute to you later. There is a document that is his with the words draft (**Exhibit D**) that should have been distributed to you. It is a

legislative proposal to prepare North Carolina's agricultural and forestry sectors for emerging carbon market place, this comes from the Environmental Defense and the Nicholas Institute. Now here is our basic plan as things now stand. We have today's meeting and I think the agenda (**Exhibit E**) is fairly self-explanatory. We are going to talk about mitigation strategies. For some of you the term mitigation may be confusing and mitigation sounds like adaptation, it is my understanding and there are others of you that know more about this than I do. We use the word mitigation when we mean ways to mitigate the impacts of carbon emissions or reduce carbon emissions so as to mitigate or reduce them. Adaptation refers to what we do in response to whatever global climate change is occurring. There have been a lot of interest and talk about adaptation so we have a good adaptation agenda item for you today.

The report from the Frontier Group which is associated with the public interest research group is very (inaudible) request of the co-chairs and then Dr. Eggers item as I indicated earlier. I've just described to you the February meeting. At the March meeting we intend to return to consider of proposals Mr. Peterson will give a very brief report on his efforts to streamline the presentation of those so that we can do that more efficiently. We will consider the proposals from Nicholas Institute and Environmental Defense and others that come our way. That will get us through March and then we will see about April and May. As things now appear, it seems very likely that we will continue this Commission for at least one more year to 2009, I've had some conversations with the leadership and as I've been saying all along, we didn't get into the climate change problem in a year or two and we will not get out of it in a year or two. There is some thought that we ought to develop a more permanent institution but the thought is that would best be done in 2009 for reasons that may be obvious to you. Those are the points that I think I need to cover. I may have more particulars on the date of the April meeting. I'll be happy to answer any questions.

Mr. Profeta: Thank you Mr. Chairman I just note that I don't see that document is distributed yet but we will make sure it gets to your desk before we're done here.

Mr. Givens: I thought it had been but I think I have the whole pile up here and we'll correct that right now.

Mr. Garrou: Dr. Riggs I am so glad you are here today when we're talking about adaptation. It would have been very disappointing if you had not been here.

Dr. Riggs: (Inaudible)

Mr. Givens: That appears on the back of your agenda under schedule of future meetings, it is Monday 11 February with the business meeting from 2:30 – 3:45 p.m. That is actually doing a breakout session of the forum. That will be in Room 2 of the McKimmon Center. While I'm talking I did have one other thing – some people do call in and let me know about their membership status. Mr. Cecich indicated he could not be here today and I appreciate knowing that. I

want to introduce the Commission to Mr. Lewis Ebert who is president and CEO of the North Carolina Citizens for Business and Industry also known as the North Carolina Chamber of Commerce. Mr. Ebert joins us in that capacity and also Douglas Crawford-Brown has indicated to the Commission that he will need to be replaced, actually I think he can replace himself since he holds this position ex-officio, for personal and family reasons he needs to reduce his demands on his schedule. So I have invited him to select his own replacement as provided by the session law.

Mr. Slocum: (Inaudible)

Mr. Givens: Yes sir for members of this Commission it is reimbursable as an expense because it is in effect an official activity an assignment if you will, for members of the Commission to attend if at all possible. No sir you should put it on the form for your February meeting. You will need to attach the receipt.

Mr. Tad Aburn: (**Exhibit F Slide presentation attached**)

Dr. Riggs. Thank you very much for the information. Most of your discussion dealt with greenhouse gas reduction emission reductions but over and over again you mentioned your aggressive approach and the risk of your coastal system. Could you give us some examples of what Maryland is doing with respect to the coastal portion and what does aggressiveness mean with respect to that.

Mr. Aburn:

Representative Allen: Thank you Mr. Chair and thank you so much Mr. Aburn. What did you say the percent of coal being used in Maryland was? Was it seven or seventy percent?

Mr. Aburn:

Mr. Glaser: Thank you Mr. Chairman. Mr. Aburn thank you for coming down with us. Mr. Aburn you referred a couple of times to the science behind an 80-90 percent reduction by the year 2050 and a difficulty in measuring what specific goals you recognized at the end. Where is that science coming from? Is that agreed upon science or is that what your commission sort of settled on as a target goal. That's the first question, the second question is do you have examples of any information relative to the cost of implementing, what type of cost is burdened by the consumer, what type of cost is burdened by the government, what type of cost is burdened by the federal government? Thank you.

Mr. Aburn:

Mr. Glaser: Mr. Chairman, if I may follow up? If I could, what I was looking for is what type of cost, you know when you talk about putting a goal in place by the

year 2015 or 2012; some body is going to have to pay that cost. I know with automobiles and transportation there is an increased cost. But I assume there has been some discussion in the state of Maryland in the Maryland Legislature about this and what I was looking for is what examples did the legislature discuss as far as the exact cost on the consumer?

Mr. Aburn:

Representative Wilkins: Thank you Mr. Chair. Mr. Aburn I would be interested in knowing the total number of employees in the Maryland Department of Environment and I would be interested in knowing if your commission has had any discussion about what the effect on that number might be?

Mr. Aburn:

Representative Wilkins: I would be interested in that information and I believe other folks in this room might be as well. Thank you.

Dr. Smith: Thank you Mr. Chair. Appreciate your presentation, two things one building off this cost question and this may be more appropriate for adaptation follow up, have you tried to quantify the impacts to Maryland in the form of sea level rise, salt water intrusion into fresh water drinking supplies, other potential impacts from storm surge. How much has the state really gone to the effort to have an ability to know what this ultimately is going to cost because when we're looking at the cost equation there is not only the direct cost of implementing these programs but the cost of inaction can be many, many times that and moving forward. So I am just curious about how much do you feel like you have a solid figure or how much effort has there been in trying to quantify the impact?

Mr. Aburn:

Dr. Smith: And I was intrigued about how you all have approached the goal question because that is an issue we are struggling with and clearly having the science drive and aspirational goal and be sort of one, and I may have missed this in your presentation, but have you all tried to assemble the policies that appear to be for lack of a better term, sort of low hanging fruit or and see which projectory that puts you on and then try to identify the gap or the delta between and a here we are now, here is where the science is saying and I know you were going to sort of four year checking I think. But how much are you attempting to look at sort of the implemental realistic policies that are sort of on the books or on the way versus the scientific goals in trying to understand the delta there and tweak them to the numbers accordingly. How does that work out in your process?

Mr. Aburn:

Dr. Smith: The 2020 goal does appear, you think, to be somewhat and that's added as sort of things on the books and on the way.

Mr. Aburn:

Senator Pittenger: Thank you Mr. Garrou. Mr. Aburn thank you for being here, Mr. Aburn do you have a formal relationship with CCS.

Mr. Aburn:

Senator Pittenger: Ok are you part of those as well?

Mr. Aburn:

Senator Pittenger: Are you a consultant to them as well?

Mr. Aburn:

Senator Pittenger: You mention a number of proposals that you all were initiating that would pay for themselves in the long run. Has there been a cost benefit analyses for those proposals?

Mr. Aburn:

Senator Pittenger: So it is yet to be determined how they will pay for themselves in the long run?

Mr. Aburn:

Senator Pittenger: The Bakom Hill Reporter, have you read that?

Mr. Aburn:

Senator Pittenger: It had some questions in terms of methodology of some of these cost benefit analyses and I was just curious what you might know about it.

Mr. Aburn:

Senator Pittenger: Ok thank you.

Representative Harrison: Thank you Mr. Chair and thank you Mr. Aburn for making the trip. I just want to follow up on the clean cars piece of your strategy. I assumed you all adopted the California standard which is subject to litigation. I saw in here a reference to taxing energy and efficient vehicles and I want a little bit more detail what you all are doing about the vehicle emissions?

Mr. Aburn:

Mr. Givens: I think I heard you mention that Maryland is projected to have a shortage of electricity fairly soon. Is Maryland a regulated state at this point or deregulated state?

Mr. Aburn:

Mr. Givens: Ok, do you have a public utilities commission left that can address the shortages or how does Maryland propose to address the shortages?

Mr. Aburn:

Mr. Givens: I would appreciate that thank you.

Dr. Everett: Could I just ask one very simple question. It would be your 13th slide on page 7 of our handout, a sampling of state targets. I just don't understand what that table is. If you could just walk through any state across the page and explain Arizona, for instance.

Mr. Aburn:

Dr. Everett: So for the Maryland example you had projected apparently that between 1990 and 2020 you would grow by 50 percent is that the projection?

Mr. Aburn:

Dr. Everett: And then, of course, your goal is to not grow that you would be 25 percent below your 2020 goal so you would cut that in half maybe, is that correct?

Mr. Aburn:

Dr. Everett: So you would still increase, you don't increase by 25?

Mr. Aburn:

Dr. Everett: So the projection as you would have been up 50 percent, your goal is to be down 25?

Mr. Aburn:

Mr. Garrou: Thank you very much Mr. Aburn for coming and speaking to us. Mr. Givens has an announcement.

Mr. Givens: Senator Pittenger has sent forward two press (**Exhibit G**) releases that are contained in a folder the sergeants will distribute that and be made a part of the record. Let me repeat what I've said to you occasionally in the past.

Members of the Commission and public to send material to the Commission and to the staff and we are glad to have it. It does not however become a part of the record unless it is handed up during the course of the meeting and read in so that the clerk can record it as an attachment to the minutes. If you have something you want added to the record, please use that procedure. Thank you Mr. Chairman.

Mr. Garrou: Our next speaker is Kenneth Colburn who is the senior consultant for the Center for Climate Strategies and he is going to talk to us about adaptation in Maryland.

Mr. Colburn: It's a delight for us to be here today. I am with CCS and Bill Dougherty is with the Stockholm Environmental Institute and does a lot of work with CCS. Bill has international experience in adaptation efforts as well. So we are pleased to offer you some initial thoughts regarding adaptation to climate change. The first and foremost concept that is important to recognize is just what new ground adaptation is, not only for the states but indeed for the globe. There is a bit of political legacy to that unfortunately as well. As many of you know, for long periods of time climate change has been viewed as mitigation or adaptation. We are going to work to solve this problem or we are going to just adjust to it. That almost became an article of faith you know, were you of the mitigation state or were you of the adaptation faith. And adaptation was viewed as the capitulation to efforts to try to solve the problem. Now that we've delayed concrete action on climate change long enough that its impacts are beginning to be visible, it is much more clear that we need to do both which is where we should have been all along in the first place. Those of you on the Commission who are readers of Governing Magazine probably saw the recent piece they did on local warming and that also brings home an important point and that is that all adaptation will be local and all the impacts of climate change will be local for states and municipalities. So states have indeed started to act and to get their arms around what adaptation means for their state, what kinds of impacts will they have to respond to and at CCS we have found that the approach was used whereby we gather stakeholders from the state, they identify a number of options, select from those options which are priorities and then dive deep into those priority options. It appears to be a workable model as well. None of those is complete at this point. Maryland is the first one out of the gate, Washington has done a little work, basically Bill will describe for you what is driving adaptation, what characterizes it and how it appears to be best approached and then I will follow up with a little bit of what's been done in some of the states who have started processes. But I'll just leave you with this is all very, very new even in the state venue and indeed globally. Thank you.

Mr. Bill Doughterty: Good morning everybody I think the first thing I would like to say is that it is a real pleasure for me to be here and talk to you a bit about adaptation to climate change. I was involved in the process in which this state here looked at mitigation of greenhouse gas emissions and so I think this topic here of how can the state begin to think about the process of adapting is not only

timely but you might even consider it an urgent matter given what the scientists are telling us about sea level rise and other aspects of the climate regime. I think what I would like to do just echoing what Ken mentioned is try to give you an overview of what I think are some of the key questions that would be worthwhile to consider as you think about tackling the problem of adaptation to climate change. I think some of these initial questions as I see them have to do with what is exactly the concern here in North Carolina? Are they concerns about the effects of climate change on coastal areas, or your water resources, are they related to the impact of climate change on public health issues, agricultural production and probably the list can go on relatively to your own particular concerns that you would bring to the table. Adding on to that is the key question of who exactly are the impacts going to hit? Who is affected by climate change? Are they the priority people, are you thinking about home owners, are they farmers, are they small businesses, large businesses and in terms of how you look at the problem it is important to think about actions that can be undertaken within the near term, say within the next five to ten years you should get the process of adaptation going and actions that would take place far into the future.

Another key question as I see it would be for what purpose is the process would you want to initiate a process of adaptation here in North Carolina to basically raise awareness among key constituents, general public, is it targeted toward major policy changes perhaps even some legislative decisions. What kind of outputs would be needed and this is, I think, a very key question. There was an earlier question by Dr. Smith about the outputs of the Maryland process and one of the key questions you might ask yourself here is the output of this effort, any potential effort in adaptation in North Carolina would be to better understand the impacts. That is to get a handle around the science, what the science is saying about what will be some of the physical impacts on the natural system here in North Carolina or are you looking for something else in terms of perhaps near term adaptation options or even long term policy decisions regarding adaptation to climate change.

And finally, you will also have to tackle with the real world issues of what kind of resources are available relative to the time that you have to tackle the problem, the capacity in terms of your institutional, technical universities, scientific capacity and all the funds available for such an effort. Rainfall runoff reduced crop yields are we talking about an increase demand for electricity to deal with higher summer heat. And finally adapted capacity focuses on what specifically exist in the state to adapt to climate change. Are the institutions prepared to deal with the issue, is the resource legislative based, is the infrastructure that's in place capable of adapting to this change in the climate. When we talk about vulnerability we are also talking about how each of these three enters play with one another. More exposure and sensitivity increases vulnerability while the more adaptive capacity they had that has defected decreased vulnerability for the impact. My sense is that any process that you are thinking about beginning here in North Carolina should really try to focus in all three of those dimensions. I've used the word probably 100 times by now, adaptation, but I never really have

taken the time to define it and I hope it has generated a question in your mind, what exactly am I talking about when I say adaptation. This slide here refers to the IPCC's definition of adaptation and if you will allow me to read it, it says that adaptation is an adjustment in natural and human systems in response to actual or expected climate stimuli or their effect which moderates harms or exploits beneficial opportunities. And that is from the 3rd assessment report.

There are two basic types of adaptation that we can talk about and the first is our economists what is called by analyst economist or reactive adaptation and it basically refers to what people tend to do, what systems tend to do as the impacts of a changing climate becomes apparent. They are reactive they are not planned they are simply what people feel is necessary to do to deal with reality that they are facing. Another is anticipatory or proactive adaptation. Here we are talking about a whole different set of measures that could be taken that focus on how to reduce the potential risk associated with what is known about climate change. And in so far as the process is being considered to take place in North Carolina it's probably a very good focus on the latter type that is anticipatory or proactive adaptation. Now adaptation is also a little different than the mitigation role in so far as the kinds of actions or measures that could be implemented are very different and they are all aimed at not reducing CO_2 emissions but rather at reducing the vulnerability of the communities in your state to the impact of climate change. And as Ken was mentioning, we've been working in Maryland on this issue and we've developed a catalog of potential adaptation actions that could be thought about in the broad sense but specifically for Maryland in the areas of coastal zones, human health and natural resources. And this universe of options is basically populated with about 200 or so actions and we took that as a basic starting point for thinking about how to whittle that down into specific relevant and pertinent actions of the state of Maryland to consider.

This is an extract from that adaptation catalogue, you will see in the left column option numbers 1.1 – 1.10, it actually goes down to page #30. And this is an adaptation extract focusing on the current built environment and infrastructure in Maryland and the second cost on the left focuses on the types of adaptation actions that could be taken. The next three columns focus on some of the evaluation criteria that the stakeholder consultations are focusing on in evaluating each of these options and then there is a place for (inaudible). In terms of a broad outline of the adaptation process in North Carolina the way I think CCS looks at it is that it probably represents the three step process. The first is initial fact finding, I have a very strong sense, although I am not familiar with the lay of the land here in North Carolina, that there is quite a bit of research on the impact of climate change that is going on at your universities and institutions and the first job would be to try to come up with a good sense of what kind of analyses has been done, how has vulnerability been defined, what are the risk, what are the key ecosystems or other systems that are at risk from climate change? The second key aspect would be state (inaudible) giving the opportunity for citizens in the state to come together and think through what makes most sense for North Carolina given your precious resources and the

issues that confront you. And finally some sort of report that provides a set of recommendations that could inform policy makers as they tackle the next big step of actually implementing some sort of program to deal with adaptation of climate change. I think that from what little I know that probably it's a safe bet in North Carolina to think about interest and adaptation focus on these four areas listed here in this slide, coastal zones, water resources, human health, and terrestrial ecosystems. I could be off their science I am not familiar with the work that has been done here, but my sense in the limited review of the literature of North Carolina is that these are probably the big ticket items in this state. With that I'll just turn it back over to Ken to give you some more specifics about what we are doing in Maryland.

Mr. Kenneth Colburn: Thank you Bill. Actually I will try to put that back up, it may be useful in just wrapping up this discussion, I will try to share a few thoughts about how Maryland and some other states have organized their thinking going in. None of these processes have ended yet so we can't provide you with the conclusions of them regrettably. But there are some insights that are emerging. What Maryland did in terms of its coastal zone protection was actually split into two technical work groups associated with coastal zones. One it called its existing built environment and infrastructure and a second being the future built environment and infrastructure. The basic thinking there being we have a whole lot of capital stock in the ground – what are we going to do with it. Some need to be protected, some need to be abandoned or is likely to be abandoned, how should we make the judgments about which is which, how do we deal with the conflicting interest about which is which and so forth. At this stage Maryland like most states is just trying to get its arms around what are the issues and parameters in metrics involved and even contemplating these kinds of decisions. A good example is they have a regulatory regime associated with 1000 ft. barrier from high tide levels. That was taken and instituted in legislation in 1972 and there is a whole different area now covered with the advent of sea level rise and the land subsiding that's occurred in Maryland. So the 1000 ft. buffer is no longer, it is more like a four or five hundred foot buffer. So that has to all be redone – so they are trying to get their arms around these kinds of issues. In terms of the future built environment, of course, the tap there is reasonably obvious. It is how do we avoid getting in a similar situation with our future construction and one of the things that's really emerged as the unified field period in Maryland is the perception that the state doesn't want to get in the business of being the insurer of last resort. You've already experienced some in property and casualty insurance companies deciding to take a pass on issuing coverage in the coastal states probably some here even in North Carolina. In some cases, I think Florida is taking a step in this direction, the state has stepped in to say ok we will cover, keep writing, we'll be your re-insurers. The trouble is when you get a major storm like which we've seen a few recently and there are substantial losses, billions of dollars of losses you're effectively saying that the state tax payers will be the re-insurance mechanism. Now if you do that (inaudible) built, the storm destroys the infrastructure rebuild it at cost, now there is a bigger storm because we haven't adapted a plan for adaptation. You rebuild it again each

time the state being insurer of last resort. Albert Einstein offered that madness is doing the same thing over again and expecting a different result.

If Maryland hasn't nailed down exactly what it is going to do in the adaptation front or at least understands Einstein's position and doesn't want to follow. Maryland also has chosen as Bill indicated here a work group investing human health, safety and public welfare and that includes everything from how to deal with diseases that are likely to occur, we will see more (inaudible) fever and more West Nile kind of thing. What sort of monitoring systems, tracking systems, early warning systems should there be on that front. Right on through public welfare being emergency warning systems, storm events have evacuation plans to help them there. What Maryland has found interestingly enough is one example, is that we normally think of storm surges as representing the biggest threat. Maryland actually had a situation last year or a couple years where major storm surged actually created the biggest problem by being a dam for the outflow for the precipitation on the land. So the flooding occurred because the surge made it effectively a dam and then the precipitation runoff flooded everything on the coast. Who would have thought of that? That is where Maryland is coming down trying to get its arms around the human health, safety, and welfare issues.

Then the fourth group is natural resources in resource based industries. Maryland has a reasonable sizeable agricultural and forestry sector but it has a huge bay community and economy and of course how to protect and continue to have as viable economic sectors those marine, agriculture and forestry industries is also a key issue of this. Preserving the natural resources in and of themselves but there is also the issue of the resource based industries. That's the sectors by which they are trying to identify and precede with options and most of those options are still in the planning stages, not only in identifying what they are, but their content because so little has been done on that front. For example, short term planning isn't linked to long term planning. Different agencies planning efforts – land use versus health and so forth aren't linked together. So a whole lot of this, at this point, I am sure will be recommendations to connect the dots. Another state that is undertaking some planning action is Washington. Washington has used a similar approach to what we just described here prospectively for North Carolina and also for what Maryland has done. The major exception there is that Washington also split off a separate water working group and that makes sense in the state of Washington because its water and snow pack really serves multiple critical purposes for their economy it is not just drinking water it is also a major agricultural industry and also its power sector which is heavily runoff and (inaudible). So three major underpinnings of their economy relate toward they also did an investigation in the water issues.

Finally I will just share a thought about Alaska which is still forming its work groups. In Alaska I am sure you have heard enough about their situation where they have tumbling trees due to melting permafrost. They have communities that are eroding including Native American communities that need to be relocated. And you can imagine the per capita cost estimates are between two hundred fifty

and five hundred thousand dollars per person to relate communities. That's a cost that may or may not be able to be avoided but to the extent that one can plan for it, it can at least be mitigated itself. And as a result of those dynamics in Alaska it is not politically feasible for Alaska to undertake an investigation of mitigation opportunities unless it also undertakes an investigation of adaptation opportunities. So you see that cart is really before the horse or in the reverse order from what we usually experience and anticipate less work on the emissions and then yet how we are going to adapt. How we are going to adapt, this is happening now and what should we be doing to try to mitigate the problem as well. I would indicate too that in identify how they are going to approach it in terms of technical working groups, Alaska is keeping the best wisdom of its state department, they will take that feedback and sort it out and then the state will identify what working groups it wants to emphasize and then we'll go from there with the process that Bill described identifying options, recognizing priorities and investigating those priorities.

And finally we had indications of interest in Florida which would be no surprise due to sea level rise and also in Arizona presumably directed to the fact that water shortages are looming under most climate modeling scenarios. So they want to get their arms around adaptation issues as well. So that is sort of a lay of the landscape a brief scan of where other states are at this point. Thanks very much for having us.

Mr. Garrou: Thank you. Are there questions for either of our guest?

Dr. Riggs: How is Maryland approaching this whole question of outreach in education of a public and political regime that wants status quo from coastal systems that they really don't want to talk about this? Have you dealt with this at all and how are you going forward to get a stakeholder involvement out there in public domain?

Mr. Colburn: The politics in Maryland have not been an obstacle at all. However, I appreciate the question because it is almost an admission on my part. I mentioned the planning side and planning for planning the other thread that falls through almost everything that Maryland has identified in plans to conduct at least their preliminary work carries through the final, heavily relates to public education and outreach. If they have 40 options at the end of the day, I expect unless they do a massive consolidation that on the order of 15 of them maybe as high as 20 will relate pretty directly to public education outreach. And I don't simply mean add to the public materials to the public, it's the sub-sectors of how do all the emergency responsive personnel communicate with each other on climate based events, catastrophic events even that kind of thing. Educating them to coordinate with this damming and outflow kind of issue is an example that we're putting under the heading of public education outreach at this point, very, very critical issue.

Dr. Riggs: Does the general population out there support this at this point and time or is it a long up hill battle that you're facing?

Mr. Colburn: No I think there is a high degree of support. I would yield to Tad Aburn to offer an at the site kind of feedback on that. But we haven't had push back or resistance at all. I would expect that any individual home owner on the coast would say yes I am all in favor except don't touch my sea wall and that kind of issue may come up because my sea wall may affect your frontage in a (inaudible) manner. So Maryland will have to work through those kinds of things. There is also a strong county and municipal government in Maryland that also has to be coordinated close to the state effort. So there is some push and pull there based on history but none about whether they should be addressing adaptation. Wrong answer, I'm sorry.

Representative Allen: Thank you Mr. Chairman this is sort of a follow up to that question. In what way is the development community involved as you're planning?

Mr. Colburn: They're reasonably heavily involved as stakeholders. There are builders on the stakeholders group itself and municipal planners and there may be others that I am not thinking about at this time.

Representative Underhill: Thank you very much you just made an illusion to don't touch my sea wall. Does that mean that Maryland does allow hardened sea wall barriers?

Mr. Colburn: It has in the past and there are some they are trying to move from a situation where that is not the solution and more of what they call softer and more natural barriers are used instead because frankly they are more flexible and adaptable and you don't run into that situation of oops the sea wall didn't work that time I guess we got to build it bigger, oops Einstein issue. In the harbor communities and smaller residential situations there are some.

Dr. Smith: Ken thanks for your presentation. I think it was touched on in your early presentation but can you go back and just talk a little bit more about the process itself as this particular group was established and can we request a list of who the participants are and just a little bit more about the actual process mechanisms that this entity is carrying in its work and if you know a little bit about some insight on some of the other places would be helpful too.

Mr. Colburn: Sure, I wasn't directly involved in Washington so I am not sure how they did that. In Maryland on their adaptation group the Department of Natural Resources is chairing that effort and it formulated the stakeholder group before we were involved with the effort so we didn't have direct input into that. Typically, on these efforts we do, but the only typical I can talk about is the mitigation side. We do provide input into the identification of categories of stakeholders. We don't know the individuals in the state so we leave that to folks convening the

effort. But it is important, let me site a Maryland example where the DNR had thought pretty concretely about the development community, had thought about the planning community, municipalities and so forth, they had almost completely omitted the health community and the emergency response types of folks. So we are building even now, much as Bill described with the 200 options, a list of conceptual categories that states may want to consider in assembling and conducting these plans. So that list will say have you thought of somebody from the building community. Have you thought of somebody from a water company, a power company so that your infrastructure elements are really there at the table because they need to be on adaptation? And then the process as Bill described, here is a set of options that we are aware from other states and other activities, what should be added to that list to accommodate adaptation most effectively here in North Carolina. Take that new and bigger list and say ok what are those options have the most residents, the most effectiveness, the highest priority in North Carolina and that list that is 200 are now 250 might then be whittled down to 40 or 50. And then with the technical work groups on a sector basis really dive into what will be involved with them, where do we stand now, what's the suggested direction and what would the policy actually look like. Would it be implemented legislatively or is it something for which already exist in executive authority and hammer that out and then submit those as recommendations at the end of the day.

Representative Harrison: Thank you Mr. Chair and thank you for the presentation. I was wondering more specifically about the coastal development management issues. It seems like most of these states that are working on this right now are in very much the preliminary stages and haven't actually gotten to the point where they are trying to make hard fast decisions on redevelopment and what kind of infrastructure, so will we be hearing about that in the future?

Mr. Colburn: Yes exactly – they are in the planning stages of what should be the policy by which they make those decisions. What are they underpinning and then I am sure there will be some struggles in the implementation process.

Representative Harrison: One thing specifically regarding Maryland, a part of the Chesapeake Bay, the agreement I think of six states were some of them involved in that or any of the other states involved in that adaptation effort or is that a regional effort there?

Mr. Colburn: They aren't at this point. The metropolitan Washington Council of Governments has been participating as an observer in the Maryland effort on mitigation and adaptation. So they are wise to it as a council of government but they are not undertaking similar efforts yet.

Mr. Urlaub: Thank you for sharing this with us today. I had a question about the adaptation group and the mitigation group or committees. Are the discussions around the policies and exploring policies and the science in the adaptation group, are you set up in a way that's informing back to the mitigation group for

them to possibly reassess or change some of the inputs into their own cost benefits analyses for the policies they looked at. Are you to that point in your process?

Mr. Colburn: I think the answer is yes and no but I can't claim credit for it, it actually goes to the state itself. In Maryland there is a commission that was established more like you all and it created a mitigation working group which is doing all the work that your CAPAG has undertaken and it also established a separate group of stakeholders there is an overlap. It's really different folk with different interest dealing with the adaptation issue. There hasn't been a cross walk to date except in a few specific conceptual issues and features but they both come together to the commission at the end of the day for recommendations to the governmental legislature. I haven't experienced any yet and that may be a function of where the adaptation process is in the game which is still only identifying its priorities is really where they are. In terms of anything technical cost related impacts where an adaptation decision would arguably increase mitigation problems with that kind of thing. Those are potential so I think what you're suggesting is to keep your eye open and indeed that is quite right.

Mr. Urlaub: Then specifically the four groups that are potential groups listed there where would you see energy come into that? For example, what comes to mind for me is rising temperatures raise the temperature of water that is going into a cooling tower of the power plant can cause power lines to sag more than that might have otherwise but they are not cooling as much and so on. And how in your process is there any feedback for seeing that kind of adaptation challenge and need for capital investment back into the evaluation of alternatives like energy efficiency?

Mr. Colburn: There hasn't been any – I don't think there is a resistance to it but it is important to distinguish as well I think between what one might call feedback loops or positive feedback loops because the vector that creates them has the effect of worsening the vector which creates even worse effects. So your example on temperature both from a cooling perspective with warmer water and with ambient air temperatures requiring even more air conditioning, those are positive feedback loops that if we keep doing business the way we are, we'll have more emissions which will worsen the problem which will create warmer water and warmer air. There has not been in the adaptation effort to date any thing as specific as saying how do we address greater sagging car lines or could we leverage efficiency more concretely on the mitigation side to avoid some of those outcomes but I think they are implicit. They are also sufficiently detailed that we probably haven't gotten to that yet in Maryland and may not in this process because at this point Maryland is still trying to get its arms around the issues well enough and it maybe that we are getting into a level of detail of infrastructure or even power distribution infrastructure but not to the level of detailing this is what should be done. Happily most of the utilities are aware of

these issues as well and are starting to already factor in adaptation - George would probably know best.

Dr. Riggs: You've implied that Maryland's way out in front of everybody else in this country, do you have any preliminary reports that would be available to us to help us lay a path and secondly are there other countries in Europe or Australia and so forth that are also involved in this to the extent that Maryland is that we can learn from?

Mr. Colburn: I would be pleased to share with you what we have and thank you for raising that because it is really a follow up to Dr. Smith's question. We would be pleased to share the categories of stakeholders that we've developed and the options that are being developed. They are all actually posted on the web. I didn't mean to imply that Maryland is light years ahead, it is just perhaps first or second out of the gate and it certainly hasn't crossed the finish line. In terms of the international Bill has far greater experience than I so I call on him for response.

Bill: Perhaps just a brief word about how the international community is treating adaptation. I think to date it is fair to say that most of the effort internationally on adaptation has focused on non industrialized or countries that are in process of industrializing, that is non annex one countries. Those countries that are not responsible for achieving reductions in their GHG levels - that is countries outside of Europe, Australia and the Eastern Europe. Now the reason for that is according to the IPCC most of the impacts associated with climate change are likely to fall disproportionately on those who are the least able to adapt. That is the poor countries, Africa and some countries in Asia and so I've been involved in a number of efforts that are looking at how can these countries adapt, places in Africa in particular? So I think that to answer to your question, most of the international focus has been on concrete actions within developing countries although much of the work there is inspired a bit by what industrialized countries think are the mechanisms that measures on possible policy action that could be taken for these developing countries.

Dr. Riggs: Just a follow up maybe a comment – I am aware that the UK is way ahead of most of us, I don't know if they are ahead of Maryland or not but the United Kingdom has done an awesome job at this and I believe Australia is out there and maybe even the Dutch and so forth. I think we can learn from what they've already done in those countries I was hoping you knew a little bit more about what was coming out of those areas.

Bill: Well you're absolutely right the UK has actually a government program on adaptation and it's very much a model for what countries in the developing world can do in so far as it tries to be a one stop shopping source for adaptation to climate change. That is what could farmers do if the rainfall variation is proving too problematic for the types of crops and other areas of the economy? So yes it is a very good example, the UK. I am not familiar with Australia and what they're

doing but I do know that the UK example in particular is one that is being looked at critically in large parts of the world.

Mr. Stephenson: One of the speakers I think had indicated that Maryland was the fourth most susceptible state to sea level rise and is there an indication what one, two and three?

Bill: You might be referring to the slide in which I showed the increase in sea level rise for three parts of the eastern coast. No. Well I think that North Carolina like its neighboring states is very much at risk associated with sea level rise. I don't think I did and I would not characterize it as a fourth most problematic state but it's definitely in an area of concern.

Mr. Profeta: I can check on that – I remember the information, I can't remember the citation but I can track it down. I believe the ranking was first most susceptible was Louisiana, second was Florida, third was North Carolina and the fourth was Maryland.

Mr. Colburn: It would sound right that it is a function of link of coastline and elevation above coastline over large areas.

Mr. Profeta: Dr. Riggs just gave me the back up that I'm right so I feel much better about saying that now.

Ms. Tompkins: Thank you Chair. Do you have any numbers or field for the trend of tourism being affected?

Bill: Well I think any time in a state like North Carolina where you have a very developed tourism industry along your coastal areas. Tourism comes to mind as one of the parts of the economy that could be really hit hard by changes in the coastal regime. In terms of any hard numbers in Maryland I can only say that they are looking at coastal areas in a very focused way as Ken was mentioning not only in what is there now, the existing infrastructure but also what the future stock would be in terms of infrastructure and the plans that would govern developing in the coastal areas..

Ms. Tompkins: How about the tax bases for beach property?

Bill: Not in terms of trends and changes no – the municipalities are quite concerned of course about that and so that is in the back of their minds as they participate in this process but (inaudible) for conclusions regarding trends no and I suspect that we are at an odd juncture where the economic trends driving coastal development are continuing even as the impacts of climate change begin to be felt and there will be some mixing of those two trends for some time, the next five years anyway.

Ms. Tompkins: Thank you.

Mr. Garrou: Thank you very much for your presentations.

Mr. Givens: We did not schedule a lunch break but at this point it seems necessary to do so. Before we do that, I indicated to you that we needed to reschedule the April meeting which is currently scheduled for the 16th the co-chairs and counsel have consulted and we believe that the most appropriate date will be Tuesday, 22nd that is the week following unless somebody has a serious objection to that, we will post that as the next meeting. Anybody have any issue with that? OK so the meeting scheduled for the 16th is rescheduled for 22nd, it will be in this room.

Mr. Garrou: Let's see if we can be back here at 12:50 to reconvene?

Lunch Break

Mr. Garrou: Called the meeting to order at 1:05 and called on Mr. Peterson.

Mr. Peterson. This is a familiar graph (**Exhibit H**) hopefully that shows the blue line of projected emission and the green line of the sum total of integrated CAPAG recommendations where they ought to be implemented. We also have developed and it is in the final report, but we have done a little bit more work to provide it more clarity is the transformation of that into a supply curve and this happens to be for the year 2020 which is one of the two analytical target years we use, the other being 2010. It shows going from left to right the dots are policy actions agreed to by the CAPAG and those that are beneath the middle black line are actions that potentially could on a net basis save money. You see a long stretch in the middle that are very close to zero and then a see starting at the right hand side that start going above zero. So this is what we call greenhouse gas abatement supply curve and that has not all but most of the 53 actions in it. Some are lacking because they were not quantified for one reason or another. Just by way of comparison there is certainly a lot of analytical work going on in many quarters looking at supply curves for greenhouse gas abatement. This is some recent work done by McKenzie and this work is in the process of being updated. This is using international data a slightly different set of methods for the year 2030 and it has a break point at a cost per ton of 40 yeros, I think that's 59 60 dollars US. I wanted to put this slide up so that you can see if this hadn't chopped off, the right hand side, what we're seeing over and over again is an "S" shaped quadratic function of greenhouse gas cost that shows plenty of opportunity for cost savings on the one end and then a long stretch that's at zero or low cost and then a stair step that goes up beyond that. So there is a lot of consistency in these supply curves world wide. We've run supply curves for many US states that look very consistent in terms of shape but every state is different and as a consequence the curves are a little bit different too. What we have begun to do is package things together so that you can have a more consolidated view of the CAPAG actions. This particular wedge graph is portraying the greenhouse gas reduction potential of actions in different sectors

in its draft because we only included in this graph the ones that had a cost per ton analyses done for them and so there are some actions not included here. But I wanted to isolate on the agricultural, forestry and waste sector that is one sector that had a long list of individual recommendations and because it covers agricultural, forestry and waste it really covers three different sectored areas. So it is more difficult to consolidate those individual recommendations into a set of thematic areas than it is most of our other options. But we've done that here anyway and we've consolidated into eight categories the specific recommendations of agricultural, forestry and waste to show how they would cluster together around areas that would logically be combined for implementation. You can see the whole package is a significant wedge in terms of reductions. I've highlighted with the green arrows the larger ticket items so immediately you see there is a set that are significant in size and there are some others that are small in size and this is just in terms of greenhouse gas production potential. We will be doing this for each of the sectors as well as providing some of the more specific notation for these consolidated wedges about what some of the key implementation barriers and needs might be in order for these to go forward. We certainly can also portray for each of these wedges and for each sector the individual supply curve or cost per ton for the individual measures. Again the take away point is there are some areas that cluster together and they are significant in size, there are a few other things that really are not and if you want to focus on the things that are bigger ticket items they jumped out pretty quickly. So this is a work in progress and I believe that we are scheduled to bring back a more detailed analyses along these lines either at the next meeting or in March and I'll be happy to take any quick questions.

Mr. Givens: Let me just comment with regard to what Mr. Peterson has told you. Two things, first of all, if you all have particular items in the CAPAG recommendations that you want him to evaluate in more detail or provide you with additional information, let us know so that we can have whatever it is and we can offer that will help you in advance of the March meeting. The other thing, I'll be talking to some of you individually, I have begun to focus on the questions of how we transition from the recommendations which are broad to actual draft legislation and if any of you who have thoughts on sources of drafts with respect to any of the proposals that are under discussion, we would be glad to see them.

Mr. Glaser: Mr. Chairman, thank you. Not a question particularly on this topic but one of the things in advance of the meeting today, one of the things that I was looking for is any source data or any information on what's taking place in developing countries, specifically Brazil, Russia, India and China relative to discussions like what we're having in Maryland and like what we're having in North Carolina. Do you know of any source that is a good source for global climate change studies or actions taking place in those countries?

Mr. Peterson: The Intergovernmental Panel on Climate Change has a chapter devoted specifically to mitigation or abatement strategies and lots of back up documents that include exactly that kind of data. The status and evaluation of

efforts taking place in other countries including the non-industrialized or emerging economies for developed nations. So that would be one of the best immediate sources. A little bit of that information has been included in this McKenzie work here, this is North America, Africa, Latin America some of Asia; but there are certainly plenty of sources but I think the starting place would be IPCC because there is a formal mechanism for gathering or reporting of that data there. That data is not particularly current or complete in comparison to a lot of other information. Dr. Dougherty is not here at the moment but he does a lot of work in those countries and we certainly could access specific studies for specific countries if you are interested.

Mr. Garrou: Just to add a little bit to that – I've looked at that study, I think the one I saw was a (inaudible) graph and I think this is the same one that McKenzie did and it is very informative. It is very well presented, got a lot of information in one place.

Ms. Preyer: Just a comment on George's suggestion and thank you for the opportunity to maybe provide some ideas about recommendations we would like to see more detail on because time is moving fast and it seems like it will be smart for all of us on the Commission to look hard at that giant package and do some narrowing of things that would be good to talk about in March. Hopefully we will do that and thanks for the offer.

Mr. Givens: Just one additional comment. Mr. Glaser's point about what is going on in the developing world is the exact response to what I was saying this morning. We will note that and pass that along to Dr. Pachauri – he is our source and we are going to have an hour with him so we reiterate, folks who have questions that are particular to the work of IPCC are encouraged to get them to us now or as soon as you can but they will be conveyed to him and we will make an effort to have him prepared to respond to that type of question.

Mr. Slocum: Tom as you move forward on finalizing the CAPAG report I hope that you will also look at the critique from the Beacon Hill group on cost benefit analysis and look to address at least some of the comments that were contained in that study.

Tom: We would be happy to. We looked at that some time in the past when it came out and received a very immediate response from our research team. We have a couple of different universities that looked at it and they would be happy to provide a comment on that. It doesn't affect the results of the process at all.

Mr. Garrou: Thank you Mr. Peterson for your presentation. Our next topic is the presentation of a report on the Impact Measuring the Impact of Climate Change on North Carolina Coastal Resources from Christopher Dumas who is an associate professor at UNC Wilmington. Thank you, sir.

Mr. Givens: As we introduce Mr. Dumas I wish I had given a little more emphasis to this at the beginning. What we are going to hear now is the cost of doing nothing which is the other side of the cost equation that doesn't often get looked at.

Mr. Christopher Dumas: Thank you Mr. Chairman, thank you Commissioners for allowing us to present the results from our recent studies. This is a joint study by several professors (**Exhibit I**) at UNC Wilmington, East Carolina University, and Appalachian State University and we appreciate the opportunity to present our study to you. This is a project that is attempting to look at the potential vulnerability of North Carolina's coastal resources to climate change. This is one of several studies that were funded simultaneously to look at potential impacts of climate change in particular regions of the United States. So not only is there a study like this that I'm going to present today about North Carolina there are also studies on several other regions that have produced or are producing similar reports. Here is a study on Alaska's potential impacts of climate change in Alaska and also I have another one on New Mexico. These are finished, others are still under way but ours is just one of sort of an effort to take the information that we have on global climate change and try to bring it down to a more regional level. These studies are funded by the National Commission on Energy Policy and the Bipartisan Institute out of Washington, DC. Again this is a joint work, East Carolina, UNC Wilmington, Duke Nicholas Institute of the Environment, Appalachian State. Professor Bin is an economist at East Carolina that worked on this study, I worked on this study myself, I am an economist at the University of North Carolina at Wilmington and I might just say that Wilmington is my home town. I am a North Carolina native so potential impacts on coastal resources are very personal for me as well as an issue professionally. Dr. Pouter from Duke University Nicholas School, (inaudible) was unable to be here today he is in Germany apparently working at the (inaudible) Institute for Climate Impact Research. Dr. John Whitehead is at Appalachian State University also worked on this report. The report is available online and I'll have information about that full report not just the glossary summary that we're handing out today. The full report is available online for download and I'll give information about that at the end of the presentation. This is one of several studies under way here is a list of the other studies that are under way, one that I am on impacts of permafrost melt and infrastructure in Alaska. One of the impacts of climate change and water resources in New Mexico and adaptation policy, impacts on forest and air quality in Tennessee, risk to Florida coastal property, impacts on water supplies in Idaho, and impacts on forest in the Upper Rocky Mountains, so our studies on the coastal North Carolina but the efforts are under way to measure impacts at the regional level across the US.

One problem that we are all familiar with today climate change, we have significant impacts on North Carolina coastal resources due to sea level rise; our potential increase in erosion and increased hurricane activity intensity. As you know, extensive development in the coastal zone in North Carolina in recent decades has put more people and more property at risk. Our report focused on

two potential types of impact, sea level rise and an increase in hurricane intensity. Sea level rise can lead to the loss of beaches or beaches for recreation and for shore fishing, also loss property, loss property value damage to infrastructure also loss to recreation benefits, recreation tourism benefits there was a question about that earlier. We've got some information on that to present at this time. And we also have another category of potential impacts hurricane intensity increases. So if our hurricanes become more intensive due to climate change it impacts our business and tourism is interrupted. Agricultural losses damage to forest and potentially also to commercial fishing.

Climate models behind the analyses – the climate model physical science portion of the report was conducted by Dr. Pouter who is in Germany now, so I am going to be presenting this information but I am not a climate scientists, I am an economist. So I am least familiar with this information, I'll just run through what I have and any detailed questions you will probably need to contact Dr. Pouter. We used climate model results from the IPCC third assessment report - the fourth assessment was not available at the time we did the study. I would like to mention that this is an initial look at potential impacts of climate change in North Carolina. We only had six months and $50,000 to do this study. We had no money to gather additional data, we had to use existing data and so this is what we were able to put together from existing data to give an initial snap shot of some of the most (inaudible) impacts might be. We used climate model results from the third assessment. From that assessment we used mid range numbers from the results of over twenty global climate models covered in the IPCC report and there is a list of lots of different climate models, if you're a climate scientist you might see your favorite climate model in there. We looked at all twenty models and tried to pick mid range estimates of changes in precipitation and temperature and sea level rise based on those models. We used the sea level rise inundation model using an eight side rule for connectivity, I have no idea what that means, see Dr. Pouter. They have several studies one under review and others they have published previously about modeling sea level rise that uses light hour elevation data and generated a raster surface, binary flooded. Not flooded raster surface basically means for different property locations along the coast we can determine based on the sea level rise scenario whether certain property parcels were flooded or not flooded as a result of gradual sea level rise. Also there is a separate storm surge model that looks at whether properties might be flooded due to storm surge or intense storm surge due to climate change resulting from hurricanes.

North Carolina is especially vulnerable to sea level rise because our topography is so flat. A one foot rise in sea level can cause inland moving of the shore line by 2,000 to 10,000 feet in some locations in northeastern coastal North Carolina. In addition to sea level rise, we also potentially face the problem that our area of shoreline is also subsiding. So the same time that sea level is increasing our land is slowly sinking. That effect is also accounted for in the model but the subsiding of the shoreline and the increase in sea level rise to obtain a net sea level rise in our area. Here is a shot of the land area at risk to sea level rise

under our different scenarios by 2100. The land at risk is in pink, red and dark red unfortunately I don't have a good shot zoom in on the coastal barrier islands that a lot of large portions of barrier islands are at risk. As you can see the impacts are more pronounced in the northeast where the topography is flatter and less pronounced down in the southeastern portion of the state where the land rises more quickly from the sea. A lot of the coastal barrier islands from the northeast end and the southeast are impacted by sea level. As far as hurricane intensity the physical model behind that we used a modified (inaudible) wind speed model to generate our base line wind speed intensity estimates. We ran hurricanes three times with hurricane tracking information from Hurricane Fran.

We downloaded from the National Oceanographic Atmospheric Administration website. We chose to look at Hurricane Fran – potential impacts of what if Hurricane Fran which folks in North Carolina are familiar with, what if Hurricane Fran became more intense in climate change. We strengthened Hurricane Fran by an amount that the climate model suggest might happen, what if that same hurricane hit but only it was strengthened due to climate change? What would the additional impacts be? We chose to look at that because we thought that was a concrete scenario that people could relate to when we're presenting our results. Of course the impacts of increased hurricane intensity would vary depending on exactly where the hurricane hit and what (inaudible) across the state. The many different possibilities they're modeling methods you can use to look at that, your Monte Carlo simulations and that kind of thing. But given the information that we had at the time and our time I do not have time to do that, we thought this would be a way to measure something that would have residence with North Carolina citizens. Scenarios were based on estimated changes in hurricane intensity according to a study by Newsome and (inaudible) that looked at potential impacts of global warming on storm activity in both the Pacific and Atlantic Oceans and we estimated changes in hurricane formation in our area off the Atlantic Ocean and the area where hurricanes are generated and then we estimated that wind speed, that was to get at our base line hurricane wind speed distribution across North Carolina due to Hurricane Fran.

Then we said what if global climate change happens, how much of this wind speed increase when you use the magic seed spending model to estimate potential increase in hurricane wind speed and distributed those increases a percentage basis spaced across the state as the simulated Hurricane Fran role strengthen Hurricane Fran roles across the state. So this track of Hurricane Fran in 1996 that is the track we're looking at for our global warming affected Hurricane Fran. Hit just south of Wilmington and then moved to the northeast across the state. It had impacts along the state but impacts were most intense down in the southeastern portion of the state.

These are some results of the model that look at what was the base line hurricane wind speeds in different counties in North Carolina looking at four example counties, Bertie County in the northeast, Carteret County, Dare County and New Hanover. What were the wind speeds in those counties caused by

Hurricane Fran and then what would the wind speed be under climate change scenarios? Even though Hurricane Fran was a category three hurricane, it only had category three winds in the eye wall. As you move out away from the center of the hurricane the wind speeds diminish so the wind speeds that are experienced by any particular county depends on where that county is located relative to the track of the hurricane. Some of the counties that we chose to study as examples had less than category three base line wind speeds as they were less affected by Hurricane Fran.

So with this physical science background context we are going to consider the impact of climate change on coastal real estate, coastal recreation tourism and general business activity, agriculture and forestry. We also considered commercial fisheries but there was very little information available on the impacts of hurricane for commercial fisheries so we are unable to present any results for commercial fisheries at that time. We utilized that range of mid range for sea level rise and hurricane intensity increases, not the best or worst case scenarios from the climate models mid range predictions. Our study assumes that no mitigation or adaptation is taking place so we are essentially estimating vulnerability, what might happen if we do nothing.

We had some great presentations earlier today from folks who are thinking about mitigation and adaptation, we're saying what if we don't pursue that and we allow climate change to happen, what might be the impact? I'll begin with recreation impact – this section of the report these results were developed by Dr. John Whitehead of Appalachian State. We have two types of recreational impacts that we looked at – beach recreation and also fishing. So there is beach recreation when you're sunning on the sand and swimming and then there is fishing. For the non fishing recreation, the beach sunning and swimming, we only have good data from southern North Carolina beaches, so for basically Morehead south. We have this data due to another study we did for the Corp. of Engineers a few years ago when we collected onsite survey data, mail and telephone survey data, on recreation that's on these beaches. So we had readily available data we could use to estimate potential impacts here. Similar data are not available for the Dare County and northeast North Carolina beaches. We were not able to estimate impacts there. So the recreations that I present are only for the southern North Carolina beaches, those northern beaches would have additional impacts beyond what I am going to present today. So here is what the sea level rise models indicate with respect to impacts on beach width. We've got some current beach width that's the 2003 column at various beaches in Carteret, Onslow, Pender, New Hanover and Brunswick Counties, then what the beach widths might be under sea level rise from the climate change scenarios in 2030 and 2080. We projected estimates of impact of 2030 and 2080 for the purposes of reporting. So as you see a number of beaches if we do nothing the beach would go to zero, so if we do not re-nourish, if we do not undertake some other types of activities we could lose significant numbers of beaches along the North Carolina coast.

Representative Wilkins: Could we have some idea of what the standard tide was here?

Mr. Dumas: The standard tide I don't know. Are you talking about at what point on the beach would beach be measured?

Representative Wilkins: Yes.

Mr. Dumas: From the line of vegetation on the dune down to mean high tide. So the base line beach width information, the 2003 column, that information is from the Corp. of Engineers we asked them for their beach width and used that in the modeling.

The point here is that the potential to lose a significant amount number of beaches as have a significant reduction in beach width if nothing is done and of course, even if you don't lose the beach if you have a significant reduction in beach width that significantly affects recreational opportunities, that makes beach recreation more congested and also of course if you lose your beach width the beach that protects your structures, the structures are more vulnerable to storm surge.

Impacts on recreation tourism – it provided additional information on economic modeling behind the recreation and tourism results if you are interested. I think Dr. Phaneuf from North Carolina State University could also give you lots of additional information on recreational modeling. He is one of the experts on that Dr. Whitehead is as well. But due to effect of the bottom line loss recreational value to local southern North Carolina beach goers estimated to be about ninety three million dollars per year by 2030, two hundred twenty-three million dollars per year by 2080. Now this is loss value to the recreations themselves. This is a measure of the production in value because they are not able to go to the beach to recreate or they have to go to other less preferred beaches in order to recreate. The model takes into account the possibility that if a certain beach is loss due to erosion, beach goers may still take a beach trip but just may go to some other beach that has been less affected. The model takes into account the substitution affects across beaches to make these impacts. In terms of production annual spending by non-local beach tourist visiting North Carolina, the reduction in out-of-staters coming to the beaches and reduction in their spending could be as much as 16 percent by 2030 or 48 percent by 2080. This significant reduction in tourism as you would expect if we lose these beaches. The annual spending amount calculations we only calculated for non-local beach tourist under the assumption that if you were a local beach visitor if you did not go to the beach you would do something else with that money, go to the movies or something else instead that still might provide economic stimulus for the region. So we only looked at non-local beach tourist to calculate the economic impact on local businesses due to reduction in recreations.

Dr. Eggers: I am a little bit confused, lost recreational value to local southern North Carolina beach goers. You said it was lost value to the individual but then you said that might go somewhere else and spend the money, so is it a contingent valuation thing you did because they are going to a beach that's not as good?

Mr. Dumas: Yes they are going to a beach that is not as good or we're not going at all. So we assume that there is no change in expenditures by local beach goers they still spend that money. There's no impact on local businesses but they have a reduction in value to them because they are undertaking a recreational activity that is less preferred. They would have gotten more personal value out of going to the beach, but if the beach is not there they will of course do something else. So they're still spending money but of less value.

Now we look at impacts on shore fishing – for shore fishing we do have information for all beaches throughout North Carolina. Twenty-eight beaches and 22 piers and information for the shore fishing impact estimate is from the National Marine Fisheries statistics survey and that provided the data that we needed to estimate impacts on shore fishing. If you lose some beach area we assume and used the model to estimate where the shore fishermen will go instead to other beaches or move to the piers and so the estimates of loss value take into account the fact that they will do their next best thing if their beaches are affected they will move to a substitute beach or to a pier and continue fishing. It's just that they enjoy that less than they would fishing in their primary location. So based on the date of the analysis the loss recreation value to local shore anglers fifteen million dollars per year by 2030, seventeen million dollars per year by 2080, these impacts are for all North Carolina beaches.

Coastal real estate – this portion of the study was conducted by Professor Bin at East Carolina University. Again we focused on four counties, here is a map of the four counties, Bertie, Dare, Carteret, New Hanover, these results only apply to property values in those counties. We have data on property values from the county tax office, parcel level data for each individual piece of property. We also have high resolution light elevation, ground elevation data to identify areas that would be inundated by sea level rise or storm surge. We also have other characteristics of property parcels distance from the shore, etc. measured using geographic information systems from GIS data. For example, here is some of the data from New Hanover County, property value of the town you're in, size of the house square footage, age of the house, bathrooms, fireplace, ocean front or not, down front or not, many different types of information used to estimate what the value of the house and the value of the property and how much of that value might be lost, what value of the property would be lost if it were in there? The picture of the (inaudible) data shows elevation data, looking from the ocean, looking back toward the coast and showing the elevation of the houses and trees and the ground.

Here are some examples of the geographic information system real estate data we've got the elevations data, ground elevation data at the top right, distance from the shore line data at the bottom left and tax parcel Centro data to the bottom right. Centro is the central locate geometric center of your piece of property. So as sea level rises or storm surge happens if the geometric center of your property is covered by water, then we consider that parcel flooded. We considered several (inaudible) scenarios, again looking here at 2030, 2080 a low, medium and high in projected sea level rise so in 2030 based on our global models, projected sea level rise could be anywhere from 0.1 to 0.2 meters along the coast by 2080 it could be from 0.3 to 0.8 along the coast. Here are some inundations flooding maps for 2080 the high scenario so out by 2080 you look at the areas that are shaded dark blue and light blue. Dark blue those are the areas that could be flooded again. This map has some call outs that you can see the effects on the coastal barrier islands in the bottom right as you can see the barrier islands are significantly affected and harder to see in the large scale map to the left but you can see there are some significant affects. Also there is some property that is affected well inland around the estuaries and sounds and also up the Cape Fear River and its tributaries. These (Inaudible) properties value model a common type of model economists use to estimate the impacts on property values, estimate the loss of value due to flooding. Current property values are subject to sea level rise in New Hanover County. Look at New Hanover County as an example we have similar results for the other three counties in the study. On the left you can look at the first column property value, current property value that's in millions. New Hanover County has 16 billion dollars in property value with a split between residential and non-residential value and then you can look at the loss property value for the various sea level rise scenarios in the columns moving to the right. So if you look at the far right column that is the worst case scenario out in 2080 New Hanover County could move 227 million dollars in property value or about1.4 percent of the existing property value in the county, of that about ¾ residential and ¼ non-residential losses, 1.4 percent of the value of the property and 1.3 percent. Now the percentage of coastal property or the property on the barrier islands loss is much higher, that percentage is a total property value in the county.

Here are similar results for Dare County and if you look at the top right percentage of the total county property value loss it could be as high as 19 percent in the worst case scenario, or 3.5 billion dollars in property value. Dare County is very low elevation and has significantly greater impact than the counties to the south like New Hanover County where land elevation rises much more quickly as you move from the sea inland.

The estimates of the property value at risk in the future in which year the damage occurs impacts the estimate of the property value loss and also the discount rate that you use. So here is a table that shows the potential impact of the economic discount rate you used on the damages that have been filed in the future. For example, look at residential property value at risk to New Hanover County, look at the bottom row, the undiscounted measure of property value at risk under the

worst case scenario the bottom row 2080 with high sea level rise, 254 million dollars with no discounting that's the value of damages occurring in 2080. However, if you take those dollar damages occurring in 2080 and discount them to present day dollars instead of being 354 million it is about 60 million dollars in damage. If you use a 0.7 percent discount rate the far right column. So the discount rate that you use affects the present value of damages that might occur in the future. So the value of property at risk to sea level rise in just four of the coastal North Carolina over the next 75 years is potentially almost seven billion dollars, the present value of the loss residential property in 2080 is 3.2 billion and when you discount at a rate of two percent. The present value of loss non-residential property is about 3.7 billion when you discount at a rate of two percent. If you discount at a higher rate then the losses are smaller.

I'm going to talk about impacts of increasing storm intensity on coastal North Carolina. This is my section of the report – again we are going to look at the impacts of increasing storm intensity in just four counties. You look at those four counties and look at the track of Hurricane Fran and say what if a hurricane with a track similar to Fran came through the state but was more intense and was increased intensity due to climate change, what might the impacts be on wind speed in the four counties? The base line wind speed caused by Hurricane Fran in the four counties are shown in the first column, tropical storm in Bertie County, a category one in Carteret, tropical storm in Dare and category two in New Hanover. If we have a climate change occur by 2030 and 2080 if that same storm came through that was more intense, you would have an increase in wind speed in some of those counties. Bertie County not much effect, tropical storm winds all the way across even with climate change due to the particular track that Fran took in this particular scenario that we're investigating. If we had more time and more money it would be much better to do a Monte Carlo study with all possible tracks of hurricanes across the state and estimate probability distributions of damages and that type of thing and that would be a much better study because of the initial snap shot.

Carteret County - if Hurricane Fran came through again with more intense instead of experiencing category one winds it would experience category two winds. New Hanover County did experience category two winds on average across the county and it could experience category three winds, so if the hurricane came through and intensity was increased what would the additional damages be? In our study we are going to assume that the frequency with which hurricanes strike North Carolina remains unchanged under climate change. Now when climate change occurs it could both increase storm intensity and increase hurricane strike frequency, the number of strikes per year or decrease the number between strikes. But the information that we had at the time did not provide information that would allow us to estimate changes in hurricane strike frequency even though we wanted to do that we discussed that extensively we could only estimate changes in intensity. If you assume that the hurricane strike frequencies remain as they have been based on historical record in North Carolina, you can see in the last 150 years you've been struck by 23 category

ones, 13 category twos, 11 category threes, and so on, Hurricane Hazel our category four that struck in the early 50's. From basic information calculate the annual frequency, the annual probability of annual chances that North Carolina will be struck by a hurricane of a given frequency. We're looking at hurricane category three, Hurricane Fran and saying what if category three hurricanes strike with the same chances every year about seven percent for a category three based on historical record but the hurricane strikes become more intense.

The first category of damages is business interruption. So business interruption are damages that result when you have a hurricane strike that is not a major storm, it is not a category four, not a category five, you don't have buildings being knocked down instead you just have downed power lines, downed trees, flooding that prevents businesses from operating as normal for a given period of time. By chance we've done a study on the economic impacts on business interruption of low intensity category hurricanes in North Carolina of a few years ago. We looked at Hurricanes Bertha, Bonnie, and Fran categories one, two and three and we did a survey of businesses in North Carolina asking how many days did it take them to return to full normal business operation following strikes by each of these hurricanes. So by business industry type we could estimate how many days it would take to return to full operation. Now this is important for the current study because our estimates of the impacts of more intense hurricanes on North Carolina involve switching among categories of low intensity storms. Some counties go from category one to category two, some from category two to category three, so most in this state we could estimate what are the additional number of days that businesses might be out of business having their business interrupted due to hurricanes becoming more intense under climate change. In addition to these data we also have information on the dollar value of output per day by county for each of these industries. Those data also take into account the fact that different counties have different industries present and those different industries present in different magnitudes. Dare County might have much more in both buildings for examples than Bertie County so we do account for the difference in industry mix across counties.

Benefit interruption losses – just four North Carolina counties, Dare, Bertie, Carteret, and New Hanover. We are not including agricultural, forestry or commercial fisheries at this point. So what might an impact be due to an increase in category hurricane three, Hurricane Fran severity only? So it could be a 34 million dollar increase in business interruption damage per storm per category three impact by 2030 and 157 million dollar increase per storm strike in 2080, just in these four counties, just for business interruption, just from category three hurricanes. If category fours and fives also become more intense and there will be additional damage for that. Also this assumes that it strikes frequently or remains the same that hurricanes also come more frequent and that would increase the damage further. Cumulative impacts for 2004 to 2080 given the probability that we are struck with category three hurricanes every year what might the impacts be by the time we get to 2080? Just due to the increase in intensity from climate change - 373 million dollars assuming no population or

income growth along the coast. If you use the state's projections of population and per capita income from the coast, it could be 1.4 billion dollars accumulative impact due to increased intensity category three storms on just those four counties along the coast. I know that statement had a lot of caveats in it but we are restricted by the limited amount of data. We hope to expand these results to account for change in hurricane frequency and consider more counties and more detail in the future.

Impacts in agriculture – there was some information available for North Carolina Agricultural Statistics Service on the impacts of hurricanes that have struck North Carolina in the past. So for example in category one hurricanes, there have been multiple strikes on average, a category one hurricane has 50 million dollars in damage, category two – 200, category three – 800 million dollars in damage. So you can see that potentially a change in hurricane category due to global warming, a change from category one to category two. It could mean significant additional damage to agriculture in the coastal region into hundreds of millions of dollars per storm strike.

Impacts on forestry – less information is available on the forest sector. There were two main studies that I was able to use that were produced by the North Carolina Forest Services Timber Damage Assessment. A study on the impacts of category two Isabel in North Carolina which did 578 million dollars in damage and category three Hurricane Fran that did 1.5 billion dollars in damage to (inaudible) to forestry in North Carolina, so based on this limited data you say well what if storm intensity increases from category two to category three, you could have hundreds of millions of dollars in additional damage to forestry in the state. That incremental impact may be smaller based on these data because of the technicality that Fran may have cleared out some weaker trees leaving fewer trees to be damaged by Isabel that came later in time; if so the incremental impacts of an increase in hurricane severity would be smaller than is indicated by looking at these numbers. I am just going to give you a ball park estimate of the significant impacts of increases in hurricane intensity on forestry. If you look at the potential impacts on climate change on North Carolina's coastal economy potential impacts of the next 75 years, loss recreation benefits could be on the order of four billion dollars. Property at risk and sea level in just four counties could be on the order of seven billion dollars, business interruption, agriculture and forestry losses could also be substantial. And again this assumes no increases in storm frequency, we look forward to results from climate and weather modelers that are improving the modeling and can give us an estimate to changes and frequency. Some of that work is going on at some of the universities in the western part of the state. Also these are potential impacts assuming no adaptation or mitigation. These results facilitate comparison of policy cost in benefits. Avoiding potential impacts that I am presenting here today would be one of the benefits of adaptation and mitigation costs.

So if you look at the cost of some of the adaptation and mitigation policies that have been identified by some of the speakers earlier today, look at the cost of

those and you think well what might we be getting for implementing these adaptation and mitigation policies, what might we get from incurring these costs? Well what you would get is you would be avoiding some of the damages that I've discussed today. I am very happy to report that the University of North Carolina Research Competitiveness Fund has recently been established and has just approved funding for additional research on this topic, North Carolina coastal hazards, economic implications of severe storms and sea level rise, a significantly larger budget and time line with respect to our project for a 288 thousand dollar study. It is joint work – East Carolina University is the lead, Professor Steve Culver and Stan Riggs are the principal investigators and also includes investigators from Western Carolina University, Appalachian State University, UNC Wilmington and the Coastal Studies Institute, it's a North Carolina wide effort. That report was due with initial results not reported, we will do that this summer and results are already under way. I had a one page handout (**Exhibit J**) that I passed around showing the projected deliverables from that report. If you're interested in what topics that report might consider you can look at that one page sheet. Not only does it look at some of the items that I've presented results on today, it also considers traditional issues like highway 12 and the Bonner Bridge and historical sites and (inaudible). So there is not only information on extending our results but also new types of impacts to be considered by this new study. If you're interested in the full technical report instead of just the four page glossy (**Exhibit K**) I've passed around today, that can be downloaded in its entirety from the website at Appalachian State. I would also like to say that North Carolina is left with a lot of work in natural hazards and climate change and we have a lot of folks working on this. Not only the folks I've mentioned today in this presentation, let me also point out the Natural Hazard Center at East Carolina University. They have gathered together a lot of great scientists and economists there and doing a lot of great work on coastal hazards, economics and physical science. In addition, the Duke University Nicholas School not only has great physical scientist, one of who was a member of our team and also some great economists including Dr. Marty Smith who is working on the dynamics of erosion, taking dynamics and we're expecting much more details than we've been able to look at in our initial report. North Carolina State has put on a great national scale workshop on economics and climate change here in Raleigh this past fall. We had folks from all around the country coming and presenting information on economics and climate change in the region. One of the highlights of that workshop in addition to what is going on in our state was a presentation by Professor Michael Hanemann from the University of California in Berkley. He heads the Center of Study for Economics for Climate Change in California and if you're looking for additional information on what is going on in California in the economics climate change I would highly recommend that you goggle Michael Hanemann at UC Berkley and find out what is going on there. And finally a commission member asked a question of the last speaker about where you might find additional information on economics of climate policies in other countries and developing countries? I might just mention Resources for the Future, another think tank located in Washington, DC that does a lot of work on natural resources and environmental economics. They have a lot of great work

on economics of global warming and climate change, not only US but around the world and they can provide additional information and additional links to other researchers around the world. With that I conclude. Thank you.

Dr. Riggs: Thank you very much for your summary presentation. I would like to ask two questions. One more specific that deals with growth rates on the coastal counties is outrageous, 40/50 percent annually so that if we project forward to 2030 and 2080 assuming that we have no limits to grow as we proceed, not only do the increasing population but the changing economics of who is building there and the big industries that are coming in and the size of the mega houses etc., it seems to me that your numbers are incredibly conservative. Have you taken into consideration or do you plan to take it into consideration those changing dynamics of growth that's question number one. Question number two, I would like to hear what you would do in phase two here assuming we can make money come available what is your next step and how do you expand this into something more than just a snap shot?

Mr. Dumas: With respect to the changes in growth over time there are several dimensions to that issue. One is that we calculated all of our results so assuming no growth to population per capita income and assuming state projections and it is true that those projections could be optimistic in terms of population and per capita income if you assume there's been some caring capacity because we run into limits. So we hope that our results that we provide sort of span the range of possibilities with respect to income growth and population growth. And we expect an increase in value that is why we also included changing per capita income. So our projections not only include for change in (inaudible) growth population but also per capita income to get us that wealth effect the fact that people might do due to increases in income build larger houses as they are doing along the coast. We also grow because of the county economies but we do not change over time based on change per capita income. We grow in value with the industries in each of the counties over time. We do not change the industry mix. Of course industry mix is likely to change over time but that is difficult to predict so for the purpose of our study we just withdrew industry mix per capita income. With respect to changes, additional issues about investigative (inaudible) budget and additional time there are several. One is we would collect beach recreation information for northeastern North Carolina similar to the type of information we had for the southern beaches. The Corp. of Engineers has such a project and ready to go. We helped them design it, we have the survey. We have the sampling plan already to go and the Corp. was about to do that but then their funding got cut. So we hope to implement that study so that we can also estimate the impacts on beach recreation in the northern part of the coast. As you know tourism recreation is a large and growing important industry. With respect to property – property value and property value at risk due to sea level rise and storm surge there are several things. One would be to extend our results to all coastal counties not just the four counties we considered, that would be one thing. The next thing would be to look at better modeling of storm surge. We feel good about the sea level rise modeling that we have done, the storm

surge modeling could be improved based on existing information based on state storm surge maps and (inaudible) model which you may be familiar with and we could improve the storm surge modeling. Also we would really like to (inaudible) property with respect to business interruption, effects on agriculture, forestry and also potentially property. We would really like to get our hands on better storm frequency information. If climate change happens how is it likely to affect the annual chances of different areas being struck by different intensity hurricanes? So essentially we would like the weather modeler to provide us with shifts in the wind speed distributions that North Carolina might experience over time due to climate change. If we had those shifts in wind speed distributions we could then calculate estimates of probabilities in terms of types of damages happening and confidence intervals and those types of things that might be valuable to policy makers who are in risk management situation. We all know that there are no certainties here just the climate are large complex dynamics (inaudible) system and it is difficult to predict. So we are trying to manage risk to the extent that we can provide estimates of probabilities and chances and complex intervals that make our results more useful in balancing benefits and cost of managing risk.

Representative Underhill: Thank you just one quick question. You mentioned the workshop that was last fall and opportunity to look over those materials if we were not there. Could you elaborate on that again, I'm sorry I just didn't follow on how to do that? Is it online?

Mr. Dumas: Sure, the workshop last fall hosted by North Carolina State University and they invited economists from across the country to talk about recent studies of economic climate change in their region and at the national level. You can find links to that workshop at the North Carolina State University Department of Economics or Agricultural Economics more likely. They have an environmental economics program there.

Mr. Slocum: Just a couple of comments with regard to the forestry sector. When Hurricane Fran hit it was in a period of pretty unusual circumstances. The hurricane hit following a fairly prolonged wet period, soils were saturated and that really exasperated the damage from the hurricane. The other thing is timber damage from a hurricane is dependent on a lot of different factors, timber size, age, soil type, soil moisture all have a dramatic impact and I would just caution against trying to model the forest as a uniform entity with regard to storm damage because it is not uniformly susceptible and your damage is not going to be uniform. In fact it is very seldom that you have state wide damage from any single storm.

Mr. Dumas: That certainly is the case so we were just trying to look at what order of magnitude effects might occur. We had changes among hurricane category based on the existing information. We did not undertake any detailed modeling on the forest sector because we didn't have the information to do that. As you point out, not only would the impacts be affected by differences in the physical environment, the biological environment at the time, that the value of the

trees lost would also be affected by what is going on in the lumber market and the housing market and all types of things that effect the price per board foot for different types of trees. So the value lost depends on many different things and it is not only location specific but it is also time specific in terms of different values market would place on. Better to be hit when you're in a recession than when you are not I guess.

Mr. Garrou: Our next presentation is from Mr. Travis Madsen, who is a policy analyst with the Frontier Group.

Mr. Madsen: Hi my name is Travis Madsen. I am a policy analyst with Frontier Group which is a nonprofit organization and we have offices in Boston, Baltimore and California which I'm visiting you from. So I appreciate the opportunity to come out here and speak to you about a report that I've just written. Frontier Group produces policy ideas and research in support of cleaner and healthier environments and a fair and more democratic society. Since 1996 our staff includes about 100 research reports addressing various topics from energy use to global warming to public health. I am here to talk to you today about our recent report called "When It Rains It Pours Global Warming and the Rising Frequency of Extreme Precipitation in the United States" (**Exhibit L**). First I am going to talk briefly about what climate scientists expect global warming to do to precipitation patterns in the United States. Then I am going to briefly talk about our study which shows that some of these impacts are already visible. I'll talk a little bit about the impacts if this trend continues in the future and then present some brief policy recommendations.

As you heard scientists are using climate models which predict what might happen in the future of different scenarios for global warming emission. As far as precipitation patterns go they expect that global warming will have a huge general effect. Some parts of the United States will receive greater amounts of rain and snow fall during the course of the year. Some parts of the United States will receive less but in general across the whole country scientists expect that more of our total annual precipitation will come in a smaller number of storms during the year. In other words when it rains it's more likely to rain harder. At the same time in between these more intense rain storms scientists expect there will be longer periods of dry weather. Let's talk about the precipitation intensity – the idea is that when it rains it's likely to produce more rainfall. This figure that is up on the screen is from the latest Intergovernmental Panel on Climate Change Report. On the left hand graph there presents precipitation intensity over time, the left side of the figure is historical information and the right side of the figure presents model results from different emission scenarios into the future. Precipitation intensity in this figure basically represents total annual rainfall divided by the number of days during the course of the year when you have precipitation. Basically what it shows is that if global warming progresses over time you can expect to get more of our rain coming in a smaller number of storms. In other words, the frequency of extreme rain and snow storms will increase. The right side of the figure, the map, shows one possible scenario for

around the year 2090. Across most of the world in fact, precipitation and intensity is projected to increase. That is especially true for temperate parts of the northern hemisphere including the United States. There are two main reasons scientists believe that this fact will happen. First is because of the warmer temperatures caused by global warming, evaporation rates will increase. So water will evaporate faster from the land and from the surface of reservoirs and rivers and from the ocean. Second, warmer air can hold more water vapors – so from satellite measurements scientists have found that for every degree Celsius increase in average temperature in the air, the air can hold about seven percent more water. In looking at satellite data over the ocean over the past several decades scientists have identified an increase in the amount of water vapor, it's going up by about 1.2 percent per decade. They are concluding that fact is primarily due to human emissions of global warming pollution. These two factors combined to enable clouds to hold a greater amount of moisture which then leads to an increased likelihood of extreme participation.

Scientists are also predicting changes in overall precipitation patterns. So across much of the United States including North Carolina the predictions for a slight increase in the total amount of annual rain and snowfall. In other parts of the country including the Desert Southwest predictions are that it will become drier. In fact that this trend has already been documented in the scientific literature, a recent report by Environment Canada showed that the annual rainfall totals in temperate parts of the Northern Hemisphere have been increasing since the 1920's. Again this impacts their primarily assigning to human emissions of global warming pollution. Additionally the distribution of rainfall during the course of the year is likely to change. In general summers are likely to become drier and winters are likely to become a little wetter. On the other side of the coin of increased precipitation we have an increased likelihood for drought. So in between the more frequent extreme storms that we are expecting we are also expecting that global warming will cause extended periods of dry weather. So this is again a figure from the Intergovernmental Panel on Climate Change report from last year.

On the left hand figure it shows the number of dry days during the course of the year and the left side is historical information and on the right side is projections for what could happen in the future. Under one scenario of global warming which is a scenario for intense emissions called A2 up on the figure, the surface area of the earth that can be subject to severe drought conditions could increase to about 30 percent of the land mass of the globe. That is compared to about one percent of the globe today. This brings me to the research that we did. We looked to see if we could see changes in precipitation intensity using weather records from the (inaudible) United States. We studied the period from 1948 to 2006 and we looked at daily precipitation records from about 3,000 weather stations across the country. At each weather station we identified the largest storms that occurred and then again at each weather station we looked at trends overtime and the frequency of these storms to see if we could see if the largest storms were increasing in frequency. The upper left figure shows a distribution of

weather stations that we used across the country. On the lower right figure shows the thresholds that we used to define what an extreme storm was. Just to re-emphasize we looked at extreme weather relative to the local climate at each individual weather station that enabled us to do a comparison of areas all across the country, many of which get totally different amounts of rainfall during the course of the year. Here in North Carolina the threshold for an extreme storm in the driest part of the state was any storm that drops more than 1.9 inches of rainfall in 24 hours. Then in the wettest part of North Carolina an extreme storm was defined as any storm that dropped more than 4.1 inches of rainfall in 24 hours and then the rest of the state had thresholds that were varied in between those areas. So another way to describe the storms that we picked and to find it extreme was they were one year storms. So in a typical year between 1948 and 2006 any given location in North Carolina would expect to see one storm of this size or larger. What we found when we looked at this information that across the United States as a whole, the frequency of these extreme precipitation events have gone up by about 24 percent since 1948. We did a statistical analyses of our data to figure out the range of competence that we have in our results and according to that with 95 percent confidence we can say that the storms have increased in frequency by somewhere between 22 and 26 percent. This graph shows our results in a graphical form on the left axis is the average annual frequency of extreme rain storms and snow storms, the 's' axis is a time period. So the green dots represent across the continental United States as a whole the average annual frequency of extreme precipitation. If there were no change happening, what we would expect is to see a trend that looks a lot like this orange dashed line that goes through the middle with about one of these storms happening every year. However, the blue line represents the actual trend. In other words, what was an extreme storm back in the 1950's would not necessarily be characterized as an extreme storm today. The intensity of storms is increasing.

We also looked at this information under more local levels. In the south Atlantic area which includes states from Maryland south to Florida, we found that extreme storms had increased in frequency by about 15 percent. Here in the state of North Carolina we found that these extreme storms had increased in frequency by about 16 percent. This map shows the trends broken down at a more local level. The boundaries represent something called climate division which are boundaries that climate scientists have used since the 1950's to aggregate weather observations. As you can see in this figure some of the most dramatic increases in storm frequency occurred in the northeast where they saw about a 62 percent increase in extreme weather. In the mid Atlantic region the increases were around 41 percent; and in other areas where especially large changes occurred were in the Ohio region in Louisiana in New Mexico and in the Pacific Northwest. We determined whether the information for each one of these climate divisions was statistically significant which basically means can we say with 95 percent confidence that a change in extreme storm frequency has actually happened in these locations. What we found was that across about a little more than half of the area of the United States there was a statistically

significant increase in extreme storm frequency. In comparison there was only four percent of the United States that showed that statistically significant decline in extreme precipitation frequency so the trend is remarkably consistent across the entire country.

This is just a blown up part of that last figure looking at North Carolina and we found three climate divisions in this state that had a statistically significant increase in extreme precipitation frequency. Those are represented by the parts of North Carolina that have diagonal lines through them, so the southeastern north central and northwest parts of the state. Our results agree with what other researchers who have looked at this subject have found. In 2004 some climate scientists published a study that looked at this phenomenal worldwide and they found that storms are increasing in intensity in locations across the world from subtropical Brazil to Siberia. They have also found trends that are related including warmer weather, higher atmospheric water content, increased formation of storm clouds and increased thunderstorm activity over the United States. More over scientists at the National Climatic Data Center have concluded that most of the increase in storm intensity that we are seeing happened in the last three decades, making this a relatively recent phenomenon.

Other scientists have also looked at lengths between what's happening and human emissions of global warming pollution and they found a human finger print on a number of different trends that are occurring including increasing levels of carbon dioxide in the air, increasing global average temperature, changing temperature extremes, the widespread melting of snow and ice, raising sea level, altered wind pattern, increasing moisture content over the ocean, and increasing annual precipitation totals in temperate parts of the Northern Hemisphere. Evidence is also growing that the increased frequency of an extreme precipitation is also linked to human emissions of global warming pollution. In the last report of the Intergovernmental Panel on Climate Change they concluded that the trend that we've seen is more likely to not link to human global warming pollution and that in the future it is very likely that we will continue to see this trend increase. What are the implications to this trend in terms of the impacts that we can see here in North Carolina and in other parts of the country. Impacts can include an increased likelihood of flooding and related risk that water pollution from runoff and from sewage overflows, increased bread or water borne disease and the damage to agriculture. On the other side of that coin, we also can see an increase likelihood of drought. In the 20th century flooding was the natural disaster that caused more property damage and loss of life than any other natural disaster. I am sure that we all are familiar with serious floods that are happening in the recent times in North Carolina. For example, there was a storm in June of 2006 that struck the Atlantic coast dropping a significant amount of rain, it wasn't a hurricane but it did cause extensive flooding in communities from North Carolina up into New York. The property damage from that storm was around one billion dollars.

At the same time when you have heavy rainfall you can have increased runoff which carries the risk of water pollution. So after heavy rain water will runoff along fields or along streets and it can bring pollutants into the water making it less suitable for drinking and less able to support a diverse community of wild life. Many communities require developments to include storm water controls to prevent runoff from becoming a problem. Often times they set in thresholds say this community must be designed in order to manage the runoff from a one year storm event. However the design criteria for what a one year storm event is, if that was formulated ten or twenty years ago, it's no longer relevant because one year storms are becoming stronger and stronger over time. Communities are going to have to consider that when they are developing runoff control regulations. Other communities are going to have to revisit the controls that are already in place to take into account the fact that storms are likely to drop more rain in the future. At the same time heavy rainfall can increase the risk that the sewage system will overflow discharging raw or partially untreated sewage into the waterways which makes them less suitable for swimming or for drinking. The EPA estimates that around one trillion gallons of raw or partially treated sewage are discharged into waterways every year. This problem could become more serious because of the trend toward increasingly intense precipitation. This also carries a risk of increased spread of water borne disease. A study that looked at all of the water borne disease outbreaks that we tracked during the last half of the 20th century found that more than half of them were preceded by a major storm event.

Heavy rainfall can also cause agricultural damage, so after a heavy rain soils can become saturated which reduces the amount of oxygen in the soils and can either kill the plants out right or make them less resilient to tests. After the flooding that happened in Mississippi River Valley in 1993 there was about six to eight billion dollars of damage to the agricultural economy there and about 70 percent of that damage was due to super saturated soils as opposed to fields that were just flooded out right. A recent study by some folks at Columbia University looked at damage to the US corn crops from heavy rain storms between 1950 and 1990. They found that heavy rains caused about three billion dollars of damage each year to the US corn crop and they predicted because of the trend towards increasingly heavy rainfall damages to the US corn crop could double by 2030. At the same time the trend toward increasingly increased precipitation also brings an increased risk of drought. So as global warming progresses we will face increasingly extended periods of dry weather especially in the summer time which is expected to become drier. Then this situation will be aggregated by the fact that higher temperatures because of global warming will increase evaporation. Therefore water is more likely to evaporate out of the surface of reservoirs and out of rivers making water less available for people in North Carolina.

In conclusion global warming is already changing our weather pattern in physical ways. The climate models predict that the trend toward increasingly intense rain and snowfall will intensify in the future and at the same time the number of dry

days will likely increase making drought more likely. The severity of these trends depends on how much global warming pollution we emit. Again if you look at this figure from the latest Intergovernmental Panel on Climate Change report, it presents three different scenarios for human emissions for global warming pollution. The green line, A2 represents a scenario in which we reach about 1200 parts per millions carbon dioxide in the atmosphere by 2100. B1 (blue line) represents roughly 600 parts per million carbon dioxide in 2100 and the red line represents somewhere around 800 parts per million carbon dioxide. So as you can see the scenario that represents the greatest control of global warming pollution in this figure shows that the least increase in storm intensity. Some amount of change is inevitable given the pollution that we've already emitted to the atmosphere but the further we go in reducing emissions the more likely we are to avoid the worst impacts of this trend.

A few policy recommendations – I think we need to establish mandatory limits on global warming pollutions. Some of the things that the speaker earlier today from Maryland was talking about seem like they are on the right track. If we reach reductions of around 20 percent by 2020 and 80 percent by 2050, we will have a reasonable chance of avoiding some of the worst impacts of global warming. If we go further the benefits will increase. Also if policy makers decide to establish a cap and trade program to reduce global warming pollution emissions, 100 percent of the emission allowances or the permits to emit global warming pollution should be put up for public auction and the funds that were raised from that auction should be used for public benefit purposes including supporting an energy efficiency and renewable programs. If we do this it will help reduce the cost of meeting the global warming targets and it will make it more likely that we will succeed.

Finally, we need to adopt policies that will improve energy efficiency and increase the use of clean renewable energy. These are really important tools that we will need to deploy in order to meet the global warming targets that the science tells us is necessary. If you're interested in seeing the full report, you can find it on the Environment North Carolina website which is listed on the bottom of this flyer. And if you would like to contact me or my colleagues with Environment North Carolina please feel free to do so at any time and I'll be happy to answer any questions.

Representative Harrison: Thank you for that report. You might have said this, 1948 that's the year that you used for your research purposes and why did you chose that year?

Mr. Madsen: That was simply a decision based on the availability of data. In 1948 the federal agency that tracks weather information, that's the point in which they started to digitized a lot of their data back to 1948 and information before that would have been a little harder to get a hold of and it would have been covering less broad geography.

Mr. Garrou: Thank you very much for your presentation. Our last presentation will be from our own commission member Dr. Eggers who will talk to us about the Intergovernmental Panel on Climate Change most recent report.

Dr. Eggers: You are about to receive a forest worth of handouts I think. So if you will wait a moment I know that you're receiving several things and so one of them is the Summary for Policymakers (**Exhibit M**) of this IPCC report, another one is just a one pager that graph(**Exhibit N**), there are two documents from Southern Alliance for Clean Energy (**Exhibits O** and **P**). One of them is kind of a summary of the summary of this report and the other one is more recent scientific findings since this report came out in November. And I think possibly the final handout is Topic 6 (**Exhibit Q**) of the IPCC report which is actually just key findings and uncertainties and I think if you are going to read anything from the IPCC report that is a good place to start. It is very brief and really tells us in a nut shell what is going on.

I am going to go ahead and get started and thank everybody who, you know we separated the weak from the strong, apparently. Thanks to everybody who is still here.

The organization of this report which is not terribly long is as follows. There are six sections, the observed changes and the effects of those changes, causes of observed changes, impact projections, near and long term, and then we've got some adaptation and mitigation and then No. 6 which I mentioned that you're receiving which is robust findings and key uncertainties. Now I want you to know that the next three or four slides are boring but necessary and they will go quickly.

It is important to realize that the IPCC attaches very specific numerical values to their language and depending on what kind of approach they take to uncertainty those values are different. So under these three approaches, qualitative, more quantitative, expert judgment, statistical analyses, they have different language. Qualitatively analyzed things have very broad language like high or medium, etc. but more quantitative is as follows. So the confidences expressed as changes in ten so if you see something that says very high confidence, that means that there is a 90 percent chance or nine chances in ten. And that they had to agree that that was actually the confidence level they were dealing with, high confidence 80 percent chance, etc. Similarly expert judgment in statistical analyses, those confidence levels are, they use different words, which helps and so to say something is extremely likely means that it has greater than a 95 percent chance of happening according to the consensus of the IPCC scientists. So later in the report you will see these words used and I wanted to put these on my slides because you don't have them on any of the other handouts, they are actually in the introduction to the long report. As well the purpose of this, just to kind of reiterate what George Givens said is to actually get us familiar with this so that we can discuss the science and any questions people might have about this

specific science in more detail at the February meeting when the head of the IPCC will be addressing us at that time. So by way of introduction here we go.

No. 1 – Warming of the climate system is unequivocal as is now evident from observations of increases in global average air and ocean temperatures, wide spread melting of snow and ice and rising global average sea level. So unequivocal is a very powerful word for the scientific body to use. Some of the specific findings are that 11 of the 12 years between 1995 and 2006 are the warmest on record. We are seeing warming to a much greater extent at higher latitudes so for example, warming in the Artic is twice as high as the global average for warming. Land is warming faster than the oceans at this time and the rate of sea level rise is increasing. The sea level is rising and it is rising faster and faster and that is due both to thermal expansion and melting glaciers and ice. What kind of effects are we seeing? According to the IPCC observational evidence from all continents and most oceans showed that many natural systems are being affected by regional climate changes, particularly temperature increases. So system affects include in their report, they say there is very high confidence that terrestrial biological systems are strongly affected and you probably saw in the news for example, robins migrating farther north than ever before and indigence people not having any word in their native language or robins because they hadn't seen them earlier leaping etc. High confidence marine and fresh water biological systems are affected but medium confidence which corresponds to just over 50 percent chances for effects on human related systems, like agriculture and forestry. And that is because it takes a little bit longer for those secondary affects to show up in these systems and it is harder to measure.

What are the causes of these effects? According to the IPCC greenhouse gas emissions from human activities have increased since pre-industrial times 70 percent between 1970 and 2004 they increased. And those primarily came from three activities, the energy supply sector, the transportation sector and the industry sector. Emissions from agricultural buildings and forestry increased but at a slower rate. So graphically you can look at representation of emissions greenhouse gas concentrations from anthropogenic emissions according to this report, now when we first started meeting, Bill Schlesinger was going back two hundred thousand years in ice core data. Now the IPCC is saying quite definitively that we are seeing higher methane and carbon dioxide levels than we've seen in the past six hundred fifty thousand and that is the state of the science. And we are seeing higher nitrous dioxide than we've seen in many thousand years. The salmon in the white represent the GIGA tons of carbon equivalent per year emissions from CO_2. The salmon color is from human activities associated with fossil fuel use and other sources and then the white is from deforestation, decay and peat. We can look also at graphical representation in 2004 this was also in the report of the concentration of gases in the atmosphere and again the salmon and white corresponding to CO_2 and we've got methane and nitrous oxide, those are really kind of driving the train that so called 'F' gases are much smaller at this point and not exerting as much

climate forcing. The lower pie chart are the sectors that are responsible for emissions and when you look at that pie there are several sectors, energy supply and industry, agricultural and forestry though account for certainly the majority of it. So what are the effects of these types of emissions? The IPCC says there is very high, very high confidence that the net effective human activities since 1750 has been one of warming and that we expect for the next two decades a warming of about 1/3 °F per decade average global temperature, the net effect due to human activities since the pre-industrial era that these activities are resulting in radiative forcing of about 1.6 watts per square meter. So stay with me on this next slide, one of the more complex, this shows the relative contribution of various things in terms of the radiative forcing effect. And in this body you've heard a lot of information about conflicting theories on radiative forcing, so the IPCC most recently is saying this is what we think is the best state of the science. Everything on the right hand side of those zeros that's on the bottom is exerting a positive radiative forcing effect in other words, it's warming. Everything on the left is exerting a cooling effect, aerosol and some changes in reflectivity of the surface. So when we look at what is really driving the train, again we see carbon dioxide emissions, methane and ozone as well, stratospheric water vapor etc. Solar irradiance folks have talked about is like actually just sun spots and solar activity, this is perfectly natural. The IPCC says this is the radiative forcing solar irradiance it's not very high but the lower kind of dark red raising line is what is due to anthropogenic activity and that's about 1.6 watts per square meter as our current estimate. You may have seen this image before, kind of a way to think about this visually is as if there were 1.6 watt little Christmas light if you will, in every square meter of the surface of the planet would be one way to think about it. That was not in the IPCC report.

Climate change impacts – what's this doing? Assuming current climate change mitigation policies, this is key assuming current climate mitigation policies and related sustainable development practices, the IPCC basically said ok we need some models of how greenhouse gas emissions are going to grow over the next few decades. So there are six SERS models and you just heard about a few of them. I am going to present all six right now and show you some of what they are predicted to do. None of these six, by the way, remember this too, none of these six is reported to be more likely than any of the other six. These are just potential directions we can grow in given our current policy landscape. The A1 scenarios assume very rapid economic growth, a mid-century population peak, and rapid technology development. There are three A1 models - A1F1 is very fossil intensive that as you guess is probably going to have very high greenhouse emissions associated. A1T is non fossil intensive and A1B is balance across all sources. Then we've go three additional models, B1 same population assumption, more rapid transitional to a service and information based economy which would be less energy intensive. B2 has an intermediate population and economic growth estimate and emphasizes local solutions to sustainability, so again far less intensive in terms of energies for transportation with B2; and A2 high population growth rate, slow economic development and slow technological change, kind of a worst case that we could follow. What would these look like if

they were mapped out? And we've received this graph before on the climate commission but every time we get it, it's in black and white and then we can look at it on the screen in color and tell what things are associated with but not on the graph. So I just took the liberty of typing on the right hand side what the different scenarios are so that you can see where the lines are if you wanted to take a look at this after this meeting. You can see that A1T and B1 are graphs that are associated with lowest greenhouse gas emissions on the right hand side. And you might be thinking wait what was A1T again and what was B1? So A1T non fossil intensive, and B1 more rapid transition to service and information based economies. I'm saying this because I think this has implications for how we think about the policies we might want to put forward from this Commission and where is the bank for the bucks, what kinds of policies will be more likely to lead us on a different path. Also be aware that these are just emissions, they are not greenhouse gas concentrations in the atmosphere, so all of these scenarios would lead to continually increase in greenhouse gas concentrations because none of the emissions go below zero. They have to go net negative to actually degrease concentrations potentially, so keep that in mind.

Under the various scenarios this graph just shows you the best estimates according to the IPCC of temperature change. They are arranged by intensity so temperature change of anywhere from 3.24 °F (and I put in Fahrenheit) the report is in Celsius) so 7.2 °F. Sea level rise also on the right hand side, now these are the IPCC averages for sea level rise under these various scenarios and North Carolina would experience significantly more sea level rise because our coast is subsiding, so the numbers are much higher for us, but these are the numbers from the report.

You have one sheet of paper that has something on it that looks like this but I cut this up for the presentation, it's printed horizontally, I think, actually the lines with the red dots at the bottom. But I wanted to go through these specifically. So what you are looking at here on the slide at the top are the different scenarios and that red dot on the horizontal line indicate the best guess for warming under that scenario. You can kind of draw a line vertically from each of those scenarios to where they correspond vertically and effects on coast and health and food etc to read under A2, I guess we are going to expect to see definitely some problems with the coast, millions of people displaced etc. etc. You can look at it that way. Also on the bottom, I have a little legend here and you don't – so the dashed lines indicate that impacts continue with increasing temperatures so that more the temperature goes up the more we see that impact. The solid lines that you will see on later slides indicate the impacts are linked, so you might see one and then with more temperature increase you would see a different impact, but it is possibly linked. And the left hand side of where the text begins shows the temperature at which we start to see that impact.

Here in front of you with coasts you can see that for almost any increase in temperature we see increased damage from floods and storms and it is not until we have more than three degrees, right now we think that we receive about 30

percent of global coastal wetlands lost. Coasts are very important so let's talk about some impacts. You saw this picture today already from upstate – we are of course uniquely vulnerable in North Carolina because we have such low lying coastal plains and we are very vulnerable to storms as well. On the right hand side Hurricane Andrew the most expensive storm before Katrina in US history and then Hurricane Floyd which was certainly very, very expensive for this state, although a much lower category storm. In our coastal plains too when Hurricane Floyd sat on us and dumped all that water, there was a huge economic impact and it impacted our food system as well. With food some of the effects we expect to see are for almost any kind of warming is a complex localized effect because all kinds of different things will happen, some areas will get warmer, some colder, some dryer, some wetter. So we will see all kinds of different things happening but we will see a lot of things happening in different areas from any change in temperature. Then the rest of this focus is on serial productivity because these are just examples, these are not necessarily what the IPCC says are the most important or anything they just wanted to show some examples of warming and outcomes.

But other effects associated with food described in the IPCC report include the following: ships in areas suitable for various crops, maybe we can grow oranges here, plant diseases increasing though in many areas where it's warmer or wetter or both, plant pest increasing, animal diseases increases, and animal productivity changes. With warming we can see increased animal productivity in some places and we will see decreased animal productivity in other places, so depending on where they start, crop productivity also changing significantly.

Impacts on human health very important and also highly costly, I put this little picture of a mosquito down here because according to some scientist at the Center for Disease Control this may be one of the most expensive problems associated with global warming is the spread of areas suitable for malaria from the mosquitoes that transmit malaria. Increasing burden from malnutrition, diarrhea disease, cardio-respiratory and infectious disease for about half a degree warming will see increasing costs associated with that. Increasing morbidity and mortality from heat waves, floods, and droughts, morbidity is just how many people get sick, mortality is of course how many people die from something so for almost any increase in temperature we will see increases in those. In changes in distribution of some disease vectors, so definitely in the report says there is a likely increase in heat waves. I'll show you about disease vectors a little bit, we'll return to that in just a minute but first water which may really be the story of the 21st century. So the report for almost any increase in temperature again increased water availability in the moist tropics and high latitudes there is not decreasing water availability and increasing drought in mid latitudes and semi-arid low latitudes. They also predict hundreds of millions of people exposed to increasing water stress to cause civil unrest. In North Carolina we're already exposed to water stress, this is the US Drought Monitor, so I got this from January 8 2008 and you can see that the darkest color that it looks to me is about half of the area of the state is what is called exceptional

drought and the red is extreme and then the remainder which is mostly orange is just severe. So that is where we are right now.

Stream flows, this is from Monday, January 14th, just two days ago, this is stream flows in North Carolina and you can see and it is no surprise that stream flows are very significantly low as well and I don't know about the rest of the state but there is a lot of talk about hay in western North Carolina and where are the people are going to get the hay over winter for their animals and hopefully a lot of folks have gotten that straightened out. So the report says there is a likely increase in areas affected by drought and a likely increase in heavy precipitation events, this is actually in Asheville, the ruminants of Hurricane Frances which came through and left 13 to 17 inches of rainfall on us in one day so the entrance to the Biltmore Estate and just (inaudible) system of the area that flooded met down there, very expensive for our community. Other outcomes the IPCC report says a very high confidence the systems related to snow, ice, frozen ground are affected and high confidence in increased runoff earlier spring melting which has a major implications for snow and glacier fed rivers and lakes, also warming of lakes. This is an actual river bed out in Washington State, early spring melting this year resulted in that river bed being virtually dry at this time. On the left hand side in the lower part of the screen, this is a salmon spawning stream. During the period when salmon would be spawning in it but it's a high stress spawning environment, very high stress spawning environment, it is completely dry, as well has a logic effect, increased runoff which you already saw so increased pollution loading, sedimentation, negative impacts on fisheries, negative impacts on coastal water quality and inter-coastal especially. The lower left hand corner, that is a reservoir that is used for hydropower generation and it's not doing a lot of hydropower generation in this picture because of course, it is very dry and up above that's a coal fired power plant, another problem that we're expecting to see is lots of cooling supplies for coal and nuclear power plants. So that is very important as we think about our energy future, we've had plants shut down in Tennessee and in France this year because of lots of cooling supplies, water cooling supplies, so that's a higher risk endeavor than we ever thought before at this point.

Impacts on ecosystems finally, increasing extinctions up to 30 percent, increasing coral bleaching, lower right hand you can see health corals and bleached corals. If we warm up a few degrees the IPCC says the terrestrial biosphere will turn into a net carbon source to warming over two degrees, turn into a net carbon source and really start positive feedback would force that pretty quickly. Species ranges also changing significantly, increasing wildfires etc, so this is a picture of our lovely mountains in western North Carolina we are predicting a lot more increasing wildfire impacts that expire in eastern Washington State, the tripod fire. There is a very likely decrease in cold days and nights predicted and frankly we all joke that whew global warming, bring it on you know especially on a day like today but remember with all those cold days and nights we have so much increase in disease vector for humans the ticks in the lower right hand corner and I could have filled up the page but that's kind of

gross for most people. But on the upper left hand corner you see wood boring insects and so major impacts potentially for forestry in North Carolina as we warm up and don't have as much bug die back, so things to think about.

In the report they talked about mitigation and adaptation at pretty great length, sections 4 and 5 are all about that. It is not a long report, I would recommend that you read it, but the report says more adaptation is required to reduce our vulnerability to climate change and a wide range of options exist now and are expected to exist under current technology trends by 2030 that for all sectors and the cost of mitigating CO_2 is averaged in the report and we know these are very big guesses economically. But $12 per ton of CO_2 for offsetting emissions or sequestration or what have you, the range in the report is negative $9 to $100 per ton with an average of 12.

So in a nutshell, I think this is the take home, the report says climate change is happening we're almost positive as positive as scientists ever get, humans are the primary cause, it will result in extensive and possibly catastrophic negative effects if no action is taken. And it is possible to significantly reduce the impacts on humans and non human systems and that the key actions required to reduce impacts are in the following areas. 1) To reduce fossil fuel consumption by expanding alternative energy, increasing generation and distribution efficiency, and low carbon energy sources and it does say nuclear in the IPCC report as part of that. To increase efficiency of cars, buildings, and industry are important. Reducing agriculture and waste emissions and increasing sequestration and finally adaptation and there is a (inaudible) on coastal adaptation in there as well. So all of these things will be required to reduce impacts on the human population and with that I'll just say do you have any questions?

(?): The terrestrial biosphere will tend toward a being a net carbon source at two degrees. Why is that?

Dr. Eggers: Increasing decomposition primarily, increasing rates of decompositions.

Dr. Riggs: Thank you for being so depressing here. How do we go forward, we're in our second year in this Climate Commission, this is an overwhelming undertaking, we heard the previous speaker talk a little bit about the economic cost to North Carolina if we do nothing in our coastal area and I would say from my experience that was incredibly conservative. But you've itemized another dozen, two dozen, three dozen issues here all of which will have an economic cost if we do nothing. This has been a very valuable experience sitting here learning about all of this, but I think it's time to get moving. I don't know how you get a Commission like this moving or I guess we've got some motion in the energy aspect of this but an awful lot of what you've mentioned hasn't even been on the table and I would like to make some kind of a motion that this Climate Commission burns some fuel and get some action going. We are all getting

older and things are changing and they are not going to wait for us. Thank you for your presentation.

Dr. Eggers: Thank you, I've heard this IPCC report called the We are All Going to Die Report and we are all going to die but let's not go down the tubes in such an unaware way as this. I think the most dangerous thing is business as usual and there is tremendous pressure for business as usual and it would be very nice if the room were entirely full for this and the last two presentations.

Mr. Garrou: Just to respond to you Dr. Riggs, we intend to start bringing forth some recommendations in March so I agree with you, we need to move.

Dr. Smith: In that spirit and building on the excellent presentations and then some of the things we heard earlier particularly the first thing that we heard about activities in Maryland earlier this morning, I don't whether these reference to whether we are the weak or the strong but those of us who are left here this late in the afternoon. I don't want to attempt to have the Commission decide anything at this moment but I do want to queue something up. It seems to me that based on the science we've heard over the course, the report this afternoon on the IPCC, the fact that we'll have distinguished guest at the Emerging Issues Forum coming up, gives us a fairly clear sense of what is a scientific goal for reductions going forward. We have also had discussions within this group about the various aggregate of policy activities that we can undertake and potential outcomes and North Carolina has taken some action over the past year. The Legislature with renewable standard and some other important provisions and those could be aggregated together to identify a suite of things that could give us a target. Where I am going is that as we discuss the concepts of a goal for reduction for the state, I think there is a goal that is based and grounded in science and as we heard from the Maryland example, may be aspirational and then there is a goal that I think it is very much within our grasp and then there is probably some gap between the two. And I guess what I wanted to queue up and I don't know if we can have a little discussion about it today, but for sure getting this in a more frank discussion going forward is, is it reasonable for us to think about having two goals one aspirational based in science and one directional based in an aggregate of policy recommendations that are achievable and can we set forth process to more fully debate that within the Commission. Because I think that is an important outcome of this stage of our work and I think it also gives us some directional targets that the fact that Dr. Riggs point so we can have some sort of benchmarks that we're accomplishing some things because there are some solid metrics being met and we have some benchmarks along the way that we can shoot for and this may then advise us going into the legislative session about what is possible. Again not seeking a formal decision at this point but wanted to queue that up and maybe think a little bit about how as a Commission we can go forward to address these opportunities.

Mr. Toben: I think this (inaudible) goal and I agree that that a discussion that could be had perhaps the March session given the agenda for February. But one

area that might be a rich vein to mind is to look at these other states that are undertaken a full study of mitigation options. Florida, California, New Jersey, New York some of the RGGI states already have enacted a number of the pieces of legislations that we are considering at least topically. I do think that those could be guides for us to look at, the CAPAG process has been a very useful process in terms of identifying large numbers of potential areas for us to explore in terms of draft legislation but it's a long distance between those recommendations and draft bills that might be considered in this upcoming session and even the 2009 session. I would encourage those of us that have particular areas of interest to really explore the other states' legislation related to those topics of interest and to bring those forward and as discussion points potentially in March or in the interim submit them to Mr. Givens for consideration and have the top seven or eight of those considered by the Commission and then discussed in the context of the sort of aggregate group and then also have the more aspirational goal as an agenda item for March.

Representative Harrison: Thank you for that presentation. I tried to get through the report and I didn't understand it nearly as well as your presentation today. I don't think I really got the context of the net radiative forcing the 1.6 watts per meter square. What's the context there if there weren't any anthropogenic impacts on global warming would be at zero or is there some naturals that can be said to solar but in terms of how we should look at 1.6 watts per meter square?

Dr. Eggers: I think from the scientific standpoint basically what that says is that as of now human activity are responsible for increasing the amount of energy on this planet and the amount we have increased it by is 1.6 watts per meter square. So it is kind of a definitive statement that human activities has increased the temperature of the planet and if we don't go off from business as usual we will continue to increase it just because of increase of greenhouse gas condensation in the atmosphere. Does that answer it?

Representative Harrison: Kind of but if we were attempting to mitigate it where would we be or if we didn't have any impact would it be at zero or 0.5 watts per meter square?

Dr. Eggers: Depends on the time scale of the analysis but basically it does depend on the science period so if we had prefect data over the entire history of the earth it would be at zero. And with that solar radius it shows that solar activity has warmed us up a little bit recently increasing solar activity but if we had the average over the history of the years it would average down to zero and the fact that there were no humans and no houses it would be zero. There would be things that would be making it cooler in certain periods of time and warmer doing certain periods of time if we just analyzed that year and that decade but over time it would be zero because it would be the average for all of those things over that time period.

Dr. Riggs: Just to add comment to that is a way to think about this is that there is a lot of stored solar energy buried in the earth that we're burning as fossil fuels and it is bringing more energy into the active system that's been stored there for hundreds of millions of years than would happen normally. This is your fossil fuel connection. Fossil fuel is stored solar energy and it has taken four hundred million years to produce our oil, we've burned it in a century.

Ms. Preyer: Thank you very much for breaking down something that is this important and was pretty formidable to most of us so I really appreciate that and based on you have experience coming as a scientist, knowing a lot about this report, you are also a commissioner and you hear the kind of concerns we are talking about of where we move forward and ideas. What would you recommend when we have this opportunity in February that we would ask the head of IPCC about and how can we take advantage of that time that would help move this commission?

Dr. Eggers: What would be optimal is that every single Commissioner be there and agreed that this is the best state of the science and we can move forward. The questions for Dr. Pachuari I think one of the most important questions for him would be: What do we know now that we didn't know in November? The answer is almost always the same. Well everything is going faster than we thought it was but here what we know now that we didn't know for the November report. Also what he thinks we need to do and personally I believe we need to go carbon negative. Eighty percent etc. etc. sounds (inaudible) but the outcome if we don't do or even if we do it is pretty bad and I think we really need to focus on sequestration. Now that is going to be a hard sell but that's the order. The sequestration is a big part of the solution and there was some proposed legislation you all got copies of today with regard to increasing soils and participating in carbon market and forestry and things like that. Great stuff to do. We can learn from other states but other states went through processes last year, two years ago when the science was not nearly as definitive as it is now. So if we follow the lead of several other states we will actually be behind the science at this point. So we probably need to also be looking at going much further in our emission reductions goal. In looking at this as a possibility Tim and I were talking about this on the side this time and last time, it would be great for North Carolina to put forward a green collar jobs initiative to really ramp up economic growth and ramp up training in the sectors where we need people trained. We need people trained who can go in and put in solar hot water systems, properly size them, properly install them, we need people who can go in and actually properly insulate homes. We need people trained to properly inspect buildings and we need to enforce our building inspection codes for new buildings. There are a lot of times new builders have spoken to inspectors who say the penetrations of the exterior wall where water and things come in and out are almost never properly sealed and air is just flying in and out so the code might be ok but the performance is terrible. So we fortunately because we haven't done much we've got tremendous opportunity. But for the state we can do a lot of job creation and we also need our community colleges and universities

to be doing different kinds of training with students so that when our engineering students graduate, when our architects graduate and even when our accountants graduate, they understand the relevance of these things and how to think about them and how to be trained actually contribute to an economic shift for the state. Otherwise, we are just talking about driving off a cliff at 5 mph.

Mr. Garrou: Thank you Dr. Eggers that was a great presentation, very helpful. Now back to the more generalized discussion.

Mr. Stephenson: Thank you Mr. Chairman, we saw several presentations on adaptation today and I think it is pretty clear that the changes that we will be facing in this state are significant from both an economic and ecological prospective. One of the recommendations that the Commission approved back in the spring of last year was to consider developing a blue ribbon commission or committee on adaptation to look at the various aspects of it both the coast and all the state. Now that the commission appears to be continuing in 2009 I think the question is how do we approach that recommendation, how do we deal with the issue of adaptation? It could be that a CAPAG process on adaptation may be appropriate to advise and provide recommendations to the commission but I just like to not lose that as we go into March and suggest that we revisit that recommendation and find a way to take action.

Ms. Tompkins: Thank you and thank you for your great clarifying presentation. I would like to ask how could something like a green collar job initiative or manifest be done in relation to this Commission? I think that it is time that we as the Paul Reveres of climate change for this state get some information out to the citizens of North Carolina, maybe doing that initiative would be one way to do that. I think the citizens of the state would like to see some time line especially if we've got another year to be working on this. So that really is a question to the chairs about how we might do that and we could continue this with emails, but maybe a brief answer now? Thank you.

Mr. Garrou: On the green education thing, there may be things that we recommend that will not require legislation. I can't think of what they are. I think most or all of our recommendations will involve recommendations to the Legislature. So we will be drafting legislation that we will present to the Legislature and ask them to pass and that will be included.

Ms. Tompkins: Could something like a green jobs state wide manifest, whatever you want to call it.

Mr. Garrou: If it is going to take money, then the General Assembly will have to appropriate it and we will have to go through the General Assembly.

Ms. Tompkins: If any of the commissioners have any creative ideas on that I would appreciate them.

Mr. Garrou: I agree with you about it is time for us to begin to educate the public about what we are going to be recommending.

Dr. Eggers: In what way would the Commission engage in education? Would this body put together a one page state of the science or state of the commission opinion and do that as a press release or how would that work?

Mr. Garrou: My thought and this is just my own thought is in connection with whatever recommendations we make of the Legislature we would want to justify those recommendations and we would want to justify them to a wider audience than simply the General Assembly. That is my own thought.

Mr. Urlaub: Thank you. Along the lines of this discussion that I know has been buzzing for a while now about green collar jobs, we've had a lot of debate in our nonprofit organization about the value of focusing on job training up front. You can train a lot of people to do something but if you still have a regulatory in policy environment that precludes companies from employing people that do those things, they are not going to find jobs at least not here. We have Appalachian State University's appropriate technology program where a lot of those students are leaving our state to go work in other states because the opportunities are not nearly as competitive here in our state. That continues to be a red flag for our organization as we access the priority order here of what we can do to go about in a simple fashion of creating a green economy for our state. We are seeing indicators that we may very well have very fundamental barriers distracting or not attracting industry here and not motivating existing industry to transition into for example the new energy economy and green jobs sectors. An evaluation of that or at least a discussion of that, like what are those remaining barriers, I know that is a really tough, it's a conflict laden and often politicized discussion and I would just hate to see us kind of opt for the easier take incentive options to spend money on a training program option without that precursor discussion.

Mr. Garrou: Good point thank you. This has been a long session but I think it has been a good one and appreciate everybody here coming and we look forward to seeing you at the Emerging Issues Forum. Thank you very much. We are adjourned.

Respectfully submitted,

Mr. John Garrou, Co-Chair
Co-Chair

Thelma T. Utley
Commission Clerk

APPENDIX

Exhibit A	Visitor Registration Sheet
Exhibit B	Emerging Issues Forum Invitation and Website Information
Exhibit C	Agenda
Exhibit D	Photocopy of NC State Alumni Magazine Cover and Information on Dr. Rajendra K. Pachauri
Exhibit E	A Legislative Proposal to Prepare North Carolina's Agriculture and Forestry Sectors for Emerging Carbon Marketplace
Exhibit F	Maryland's Climate Action Plan Establishing Goals by Tad Aburn
Exhibit G	Press Releases – N. C. Energy Policy Model 'Not Credible' and Serious Problems 'Plague' NC Climate Change Report – Senator Pittenger
Exhibit H	Background for a Process on Adaptation to Climate Change in North Carolina – Climate Action Plan Advisory Group
Exhibit I	Impacts of Global Warming on North Carolina's Coastal Economy (2) – Chris Dumas
Exhibit J	Planned Work Products: "North Carolina Coastal Hazards-Economic Implications of Severe Storms and Sea-Level Rise" – Steve Culver
Exhibit K	Environmental Defense News Release and Florida and Climate Change – The Costs of Inaction – Dr. Frank Ackerman
Exhibit L	When It Rains, It Pours – Travis Madsen
Exhibit M	Intergovernmental Panel on Climate Change Fourth Assessment Report – Dr. Eggers
Exhibit N	Examples of Impacts Associated With Global Average Temperature Change – Dr. Eggers
Exhibit O	IPCC Fourth Assessment Report: Summary and Key Findings – Dr. Eggers
Exhibit P	Southern Alliance for Clean Energy – Dr. Eggers
Exhibit Q	Topic 6 – Robust Findings, Key Uncertainties – Dr. Eggers

DRAFT

Global Climate Change Commission
February 11, 2008
Room 3 McKimmon Center
North Carolina State University

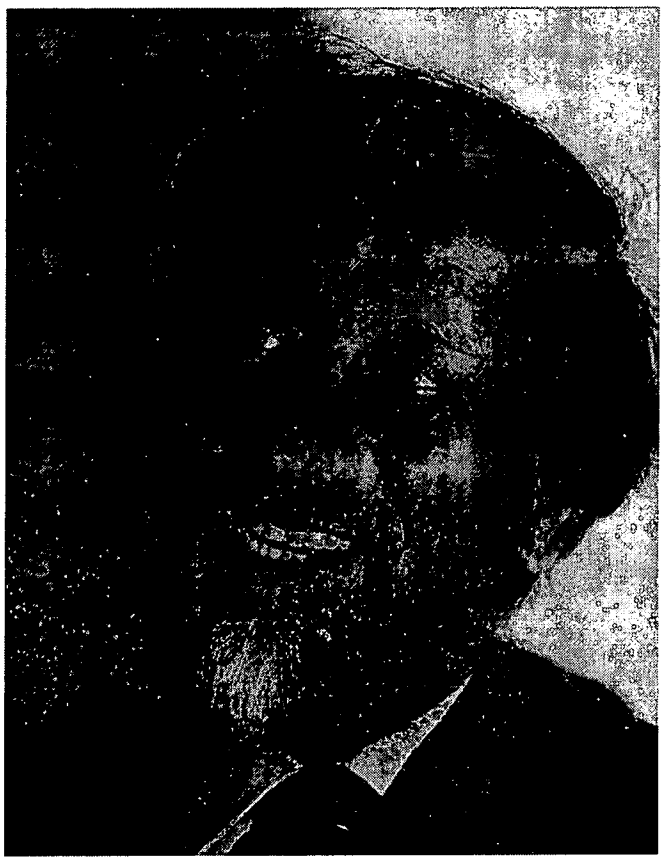
Minutes

Co-Chair Representative Pricey Harrison called the meeting to order at 1:00 pm and welcomed all members of the commission and visitors. She then introduced George Givens, General Counsel, who reminded the members to sign and turn in their reimbursement forms. He informed them that were entitled to two days reimbursement for attending the Institute for Emerging Issues Forum being held at the McKimmon Center at North Carolina State University. He also went over the schedule of future meetings.

Mr. Givens also thanked the Institute for emerging Issues, especially Diane Sherry, for making this particular facility available to the commission and making arrangements for Dr. Pachauri to be available to speak to the commission. Mr. Givens reminded the commission that they are committed to getting Dr. Pachauri back to the forum in one hour. And with no further ado Mr. Givens said that "it is an honor to introduce Dr. Pachauri to you".

Please see the following page for Mr. Givens Introduction of Dr. Pachauri.

Rajendra Pachauri



Mr. Rajendra Kumar Pachauri was elected Chairman of the Intergovernmental Panel on Climate Change (IPCC) in 2002. The IPCC, established and co-sponsored by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP), is the leading body for the scientific assessment of climate change.

Mr. Pachauri has been involved in the work of the IPCC since its Second Assessment Report in 1995, as a Lead Author. He was then Vice-President of the IPCC during the Third Assessment Report.

Mr. Pachauri has been the head of TERI, The Energy and Resources Institute, since its establishment 25 years ago. TERI is an international institute of excellence headquartered in New Delhi. Its work is focused on scientific and technological

research and strategic thinking in the fields of energy, environment, forestry, biotechnology, conservation of natural resources and sustainable development.

To acknowledge his immense contributions to the field of environment, he was awarded the Padma Bhushan by the President of India in January 2001, one of India's highest civilian awards. Among other awards he received, he was honored "Officier De La Légion D'Honneur" by the Government of France in 2006.

Mr. Pachauri was born in Nainatal, India, on 20 August 1940. He completed his studies in the North Carolina State University in Raleigh, USA, where he obtained an MS in industrial engineering in 1972, a Ph.D. in industrial engineering and a Ph.D. in economics. He taught at various universities in India and the USA, including at the School of Forestry and Environmental Studies, Yale University, in 2000. He was Research Fellow at The World Bank, Washington, DC in 1990.

He was adviser to the Administrator of the United Nations Development Programme (UNDP) in the fields of energy and sustainable management of natural resources from 1994 till 1999.

Mr. Pachauri's wide-ranging expertise has resulted in his membership of various international and national committees and boards of academic, research, civil, professional and corporate institutions. At the international level, he has been President of the Asian Energy Institute since 1992. Among other positions, he just joined the board of the Global Humanitarian Forum, recently founded by former United Nations Secretary General Kofi Annan. He's member of the International Advisory Board of the Toyota Motor Corporation; member of the Wise Men's Council of the Asian Development Bank. He was previously member of the Board of the International Solar Energy Society.

On the national level, he's at present member of the Indian Prime Minister's Advisory Council on Climate Change, while from 1999 to 2004 he has been a member of the Prime Minister's Economic Advisory Council. He holds non-functional positions on the Board of Directors of the Oil and Natural Gas Corporation Ltd, India's principal energy company and on the board of the National Thermal Power Corporation, India's largest power producer. He's member of the Board of Directors of the Institute for Global Environmental Strategies (IGES), Environment Agency, Government of Japan. He is also the Chairman of the Board of Directors of the Darjeeling Himalayan Railway Heritage Foundation.

Mr. Pachauri authored 23 books (among which a book on English poetry) and many papers and articles.

Mr. Pachauri is an active cricketer.

Dr. Pachuari:

Welcome members of the legislative commission on global climate change. I'm very grateful to you distinguished ladies and gentlemen for giving me this opportunity; to me this is like a homecoming. I'm an alumnus of NC State University and I owe a great deal to the state of North Carolina. I would say that the modest achievements that I have had really can be attributed to what I learned in this state, so thank you very much. It's a wonderful feeling to be back here and to talk to this distinguished group, which I'm sure will have much to do with the future of this state and of course the future of the world and the human race. I will run through some facts that come out of the IPCC fourth assessment report and without further ado. I will first give you a brief history of what we know about climate change. This is something that was essentially investigated by Swedish scientists more than 100 years ago, by the name of Dr. Henricus, who incidentally won the Nobel Prize for chemistry, I think in 1896, if I'm not mistaken. He calculated through a series of equations on what would happen to the climate of this earth if carbon dioxide increased in concentration in the atmosphere. And I must say a lot of these conclusions and findings have been drawn out by the realities instead. In 1988, as some of you honorable members would remember, was an extremely hot period where there was also extensive drought throughout North America. It was then that James Hanson, a very well known scientist who had been working on global climate change for a long time, appeared before the U.S. Congress and put forward the view that global warming is already happening. That created a lot of sensation, a great deal of stir all over the world and it was then that the UN General Assembly said that the IPCC should be established as a body to look into all aspects of climate change and carry out regular assessments in climate change. Fortunately this was not established to the UN body, it was established as an intergovernmental panel, where essentially decisions are taken by all the governments of the world and it's an autonomous body, even though it was established under the umbrella of the one (inaudible) organization and the United Nations environmental program. So it doesn't receive any funds from the U.N., it's not directly under the control of the U.N., it's an intergovernmental body where all the governments of the world take decisions of the basis of consensus and I must say in the twenty years of the existence of this body its had a remarkable record of being able to reach consensus. In my view if one establishes a tradition and a spirit of doing things in a particular way, as difficult as they may be, that essentially becomes a precedent for others to follow in the future. I think that's really been the case with the IPCC. In 1992 the U.N. framework convention on climate change was agreed to and in 1997 the Kyoto protocol came into existence, though of course it was not ratified and until its ratification it only a protocol that essentially existed on paper. 2005 was the warmest year since record keeping began in the mid-19th century and this was also the year when the Kyoto protocol went into effect, with the ratification by Russia, which essentially was the last country that was required to ratify, to give it the essential numbers that were required for ratification. Now the work of the IPCC as I mentioned, is guided by the mandate which was given by the (inaudible) organizations and its role is to assess on a comprehensive, objective, and transparent basis scientific, technical and socio-economic information relevant to understanding the scientific basis of climate change, its potential impacts, and the options for adaptation and mitigation. I want to emphasize that the IPCC by itself doesn't do any

research, it mobilizes the best experts and scientists from all over the world and we carry our an assessment of climate change based on peer-reviewed literature, so everything that we look at and take into account in our assessments has to carry credibility of peer-reviewed publications, we don't settle for anything less than that. So essentially it is the work of the scientific community drawn from all over the world that provides us with the material for our assessment. The writing and review processes is very robust, very vigorous, we first have experts review the first draft of the report, then governmental experts review the second draft of the report and the draft a summary for policy makers. Then finally, governments review word by word the revised draft summary for policy makers and I might mention the policy war, the summary for policy makers is something that has to be approved by all the governments literally word by word. That causes very complex job, because you have diverse interests, diverse levels of expertise and know-how, but I must say, in the end, we do manage to arrive at the consensus. Sometimes it can be a very painful and slow process by which we get agreement, but so far we have succeeded in getting it. Just to give you some facts, the fourth assessment report to the IPCC, which was completed last year culminating in the synthesis report which was released in November of last year, required and it won 2,500 scientific expert reviews. The (inaudible) contributing authors, these are people who provide inputs on their specific expertise. There are 450 lead authors. These are the people who actually do the writing. They came from over 130 countries. So it's clearly an undertaking of mammoth proportions and great complexity, but the good news is that we've been able to find agreement and find consensus for everything that is published in the end. One major finding that we had in the fourth assessment report was what is projected before you, that warming of the climate system is inequitable, its beyond any scientific doubt and it's something that is now very clear, because it's based on observations of increases in average air and ocean temperatures, the widespread melting of snow and ice, and rising average sea levels. The melting of snow and ice is something that is happening at a very rapid rate across the globe. For instance, I've been in the artic region myself and I've seen the kinds of changes that are taking place over there. Three weeks ago I was to go to Antarctica with the Norwegian Prime Minister; unfortunately with all the extensive travel I do I came with a bad attack of the flu and had to cancel the trip. I'm just itching to get there one of these days. I'll also be going to Greenland, where major changes are taking place. To give you a perspective over a period of time, let me mention that the warmth of the last half century is unusually increasing, at least in the last 1300 years and the last time the Polar Regions were significantly warmer than present for an extended period was 125,000 years ago. Reductions in polar ice (inaudible) 4-6 feet. I do want to emphasize however that when that warming took place 125,000 years ago the reasons were very different. That was essentially on account of changes in the position of the earth in relation to the position of the sun and that caused warming, significantly more than we have today. It's only to emphasize the fact that if we continue this warming for long periods of time, then clearly we could be facing the same risks that were faced by this planet 125,000 years ago. This is a chart of all the changes in global climate surface temperature that have taken place since industrialization began and you see these dots through which the line has been drawn, essentially to capture the changes that have taken place. There are ups and downs, as you will see, and that's largely because solar activity does influence the climate of this earth and there are some spots, the eruption of

volcanoes, that has an impact on the climate of the earth, and of course human intervention through the increase in greenhouse gases in the earth's atmosphere. Now what is significant is period beyond the middle of the last century to where we are today and you will see that there has been a very rapid increase in temperature in this period. If you draw this line, covering a period of 100 years you would get a slope that gives you an increase of .074 degrees Centigrade/Celsius in this entire 100 year period, but if you look at the last 50 years you get a much, much steeper line which is equivalent to 0.128 degrees Celsius increase in temperature in this period. In other words, in the last 50 years the rate of increase of temperature has been higher than the rate of increase in the previous hundred year period. We also know that eleven of the last twelve years rank amount the twelve warmest years in the instrumental record of global surface temperature. We now have pretty firm observation, a great deal of data, on the basis which we can come to these conclusions on measurement of changes. This gives you the cumulative balance of glacier mass in different parts of the world. You will see there's been a shape decline in the size of the body of ice in these glaciers. Not such a susceptible change in the case off the glaciers in Europe and the Andes mountains, but elsewhere there's been a very rapid decline. This clearly means that if we look at the impact of this sea level rise, it can be substantial (inaudible) because all that mass of ice is flowing into the oceans and adding to sea level rise. This is a part of sea level rise and during the last century the increase in sea level has been about 17 centimeters, this is on the basis of actual measurements and our projections for this century are anywhere from 18-59 centimeters, but we're hesitant to place an upper limit on sea level rise because it's entirely possible that with rapid melting of the west Antarctic ice sheet and Greenland, these are large bodies of ice that are sitting on land, and if these were to collapse as a result of the rapid melting that is taking place over there, then we would have sea level rise of several meters. Now here again I might point out that global average sea level has risen since '61 at an average rate of 1.8 millimeters per year and since 1993 at 3.1 millimeters per year. Just to make the translation from metric numbers to the foot/pound system I mentioned that during the last century sea level rise has been 17 centimeters, that's pretty close to a foot in terms of increase, I would say about .75 or ¾'s of a foot in terms of increase in sea level. There are other changes in climates that are taking place which are well documented, for instance the extreme precipitation events. This is happening around the globe. You find that you get a large quantity of rain or snow in a short period of time which clearly causes some serious problems. There's been an increase in heat waves and of course the worst example, which I'm not (inaudible) human induced climate change, was what happened in 2003 in Europe, when around 20,000 people died in Paris and the surrounding areas. There have been changes in cyclonic activity and certainly an increase in drought as well as floods. If you look at the causes of change, there's been an substantial increase in the emissions of green house gases, carbon dioxide being the most prominent and also therefore as a consequence, substantial increase in the concentration of these gases. The atmospheric concentration of carbon dioxide in 2005 exceeds by far the maximum rate over the last 650,000 years. You might ask how do we tell what happened in this entire period of 650,000 years, fortunately science has reached a stage where through the drilling of ice cores in these large quantities of ice in the Antarctic region and elsewhere, we're able to pinpoint exactly when the ice was formed. We see air trapped in those little pieces of ice, that air, when

analyzed, can tell you exactly what the carbon dioxide concentration was at that point in time, because when you get snowfall over perhaps millions of years, all that snow keeps coming down and newer layers keep mounting on it over a period of time. So it's relatively easy now for scientists to tell exactly to drill deep and to be able to pinpoint exactly the period when that ice was formed historically. Also, global greenhouse gas emissions have been on the increase in recent years due to human activities and their influence since pre-industrial time, substantially with an increase between 1970 and 2004. Now I just want to make an observation. I lived in this part of the world in the early 70s and I recall in 1973-74 when oil prices quadrupled worldwide after the out of oil wipe up. As some of you distinguished ladies and gentlemen would remember, that one had to stand in line early in the morning and get $3 or $5 worth of gasoline and I think all of that really had a major impact in bringing about major improvement in automobile efficiency. In fact I don't mind confessing to this distinguished audience, I had this youthful desire to buy a nice large luxury car and I bought a Roles 98 for almost a song, it cost me nothing and I drove it for almost a year and that's the only time when I've had an inefficient car to drive all over the place. The point I'm making is that soon after that there was a major one worldwide effort to bring about improvements in energy efficiency and that carried on until about 1985 or so, but then oil price crashed. As a matter of fact, I wrote a book which was published by John Hopkins University Press in 1985, in which I had projected an increase in oil prices in the future, but almost a week after the book was release oil prices crashed, with it the sales of my book. My only consolation was that I wasn't the only one who was wrong; there were several other, much bigger people, who made the same mistake. The point I'm making also is the fact that somehow we've lost site of the whole issue of energy security and all the other benefits that go along with it and we've been continuing to increase our emissions in the last 3 ½ decades. Now most of the observed increase in temperatures since the late 20th century is very likely due to the observed increase in natural progienic greenhouse gas concentration. Now this is a significant finding that we have come up with in the IPCC fourth assessment report and when we use the term "very likely" it represents the probability of over 90%. So in other words the warming that is taking place, since the middle of the 20th century is most probably the result of human use climate change. And CO2 annual emissions grow by about 80% between 1970 and 2004. So while green house gas emissions have grown 17% and carbon dioxide has been growing even faster, which means that we've been continuing to burn more and more fossil fuels. Now, if we look at causes of change, what you see over here is the result of climate models, which are very sophisticated, they run on very powerful computers these days and what began as a result is this grouping of projections for the past using only natural forcing. In other words only natural factors like solar activity, the eruption of volcanoes and so on, but if we run those models using both natural and anthropogenic forces, both natural as well as human factors, this is the kind of plot that we get for the 20th century. Now, if we were to compare this with the actual observations and this is what we end up with. So the point I'm trying to make is that fortunately climate modeling is now reached a level of reliability, where we have a very high level of confidence in what we are saying and what we are projecting for the future. Observed (inaudible) patterns of warming are only observed by models which include anthropogenic forces, so in other words, if you were to leave off the human factors and the human drivers of climate change, then I think we would be total wrong in coming up

with projections of the future. We now know that continued emissions of greenhouse gases at or above concentrate to cause further warming and induce many changes in the global climate system during the 21st century and this will very likely be very larger than those observed during the 20th century. Now if we look at projections for the future what you find in this diagram is different shades of warming that we could project. For instance the darker shades represent high levels of temperature increase and the lighter shades are somewhat at the other end. It's interesting to observe that the highest warming is going to take this in the upper latitude of the northern hemisphere, that's where you'll get the darker shades. This is brought on by facts; even today the Arctic is warming at twice the rate of the rest of the globe and if you look at projections for the future this trend remotely intensifies. Now that again is going to cause problems because the Arctic region is going to lose a great deal of ice. I might also say that they might be other forms of tensions that would arise because shipping in the Arctic region will become almost an annual business. Its lot would be confined to two or three months of open sea routes and therefore it is likely to be a lot of competition for the resources in that region. The honorable members would know that some months ago Russia planted it's flag at the bottom of the North Pole which signifies the fact that they would want to get the resources over there but 25% of the hydro-carbon resources that have not been found yet in the world are supposed to lie in that region. So there's a lot of competition that's going to increase as a result, because shipping will become much easier. This clearly means that climate change is not going to be uniform, that there are some parts of the world that are going to be effected far more than others and I'm only talking about temperature changes at this point in time. In actual fact there are several other impacts that I would get into. Our projections for the future, for the end of the 21st century are that at the lower end of the scenarios that we can project we get a best estimate of 1.8 degrees Centigrade and at the upper end, about 4 degrees Centigrade, at the end of the 21st century. Now in the last century, and I just want to mention the exact temperature increase was about 0.74 degrees Centigrade. So if you were to combine that with even the 1.8 degrees Centigrade increase that would take place at the lower end of the scenarios, that gives you a total temperature increase of over 2.5 degrees, which is pretty serious. We also know that there could be a front of irreversible impacts. Partial melts of ice sheets from polar lands would imply several meters of sea level rise and this really means Greenland and the rest of Antarctic ice sheets. We've assessed a number of species in the IPCC and our assessment is that 20-30% of the species are likely to be at risk of extinction. Increases in warming exceed 1.5 – 2.5 degrees Centigrade. In North America, warming in western mountains is predicted to cause decreased snow pack and reduce summer flows, excavating competition for over allocated water resources, increased number, intensity, and duration of heat waves allow potential for adverse health impacts, and coastal communities and habitats will be increasingly stressed by climate change impacts interacting the development and pollution. So the coastal communities are particularly vulnerable to the impacts of climate change. One worry is that there are several populations which are going to be very vulnerable. The four (inaudible) that are more dependent on climate sensitive resources. The four in the world really don't have irrigation, they are dependent on rainfall. Their soil conditions cannot be improved through artificial means and they are therefore are dependent on that and a lot of their food, fiber and fuel comes from harvest and biomass. One vulnerability in Asia, Africa and Latin America is aggravated

by other particle stresses and within other areas the poorer, modernized communities (inaudible) are particularly at risk and I might mention that even though I'm not connecting Hurricane Katrina with human induced climate change, the impacts of that particular event were particularly sever for the poorest communities in New Orleans for instance. Because they just didn't have the means by which they could have withstood this terrible happening and therefore what I'd like to emphasize is that the poorer, in a (inaudible) way they live, it could be poor countries or prosperous countries, they are certainly at a disadvantage. Now the fact that the Norwegian nobility decided to give the Peace prize for 2007 to the IPCC and former Vice President Al Gore in some sense signifies the link that they saw between climate change and threats to stability in human security. Climate change could impact adversely basic human needs, access to food, access to water and stable health conditions. Coastal dentures are particularly vulnerable. This is a picture of most dentures in different parts of the world that would be highly vulnerable. The red ones are extreme cases, the brown dots are high cases and black dots are medium vulnerability. The most effected would be the mega-dentures in Asia, which includes cities like Shanghai, (inaudible) which have very high concentrations of populations, a great deal of property and infrastructure, all of which would be highly vulnerable in the case of coastal flooding. So these are areas that obviously would have to take some steps to adapt to this threat of climate change and their risks are expected to increase rapidly by coastal settlements (inaudible) increased risks above sea level rise. Agricultural activity at low latitudes are likely to suffer severe losses because of high temperature, drought, flood conditions, soil degradation. I can tell you on the basis of research that's been done in several developing countries, there's already a perceptible decline that's been measured, in years and productivity as a result of the impacts of climate change. Now this has implications for food security worldwide. Now our assessment is that there's a possible year reduction of 50% by 2020 in some African countries and these are countries that are already stressed with malnutrition and burdens of food supply, 30% possible year reductions by 2015 in Central and South Asia, 30% reduction by 2018 in Latin America. More significantly crop revenues could fall by 90% by the end of the century in Africa. Now when that happens, these communities will really have no choice but to move away from there and that represents a threat to security and peace in that region. So they would really not be able to carry out any of the agriculture with this drop in revenue that is likely to occur. Water availability is also likely to be affected, because of changes in precipitation factors, increases in (inaudible) of ground water, and glaciers melting, which would decrease river flows. The rates of people exposed to increased stress have been projected anywhere from 120 million to 1.2 billion in Asia by 2020, as early as that, 75-250 million in Africa by 2020, 16-24 million in Europe by 2017. Human health would be affected with these deaths, disease and injury, due to heat waves, storms, floods, fires and droughts. Increased frequency of cardio respiratory disease at higher temperature, increases in malnutrition and consequent disorders, increase (inaudible) disease, excavation of abundance and/or toxicity of cauldron. In general I might mention that (inaudible) diseases will increase because with higher temperatures a lot of organisms that carry disease will be able to thrive and perhaps multiply. Now may I submit that if one wants to look at the impacts of climate change in any area, it's absolutely essential that one carries out a study of the impacts specific to that particular region. In the case of North Carolina there's need to look at

what might happen to coastal settlements, mountain ecology, human health, agriculture, and water resources, because if this research would be carried out in the next 2-3 years, I think this distinguished body would be in a much better position to recommend the kinds of adaptation that would be required. Because on a (inaudible) basis it's absolutely essential that adaptation has to be taken and even if you were to stabilize the concentration of greenhouse gases at current levels, climate change and it's impacts will continue for several decades and therefore there will be no choice but to adapt to the impacts of climate change over a period of time. For instance, if you were to stabilize the concentrations today, for the next two decades there would be a change in temperature of about 0.1 degrees Celsius over a decade. There's also a certain inertia in the energy system because you have power plants, you have a whole lot of infrastructure where you really can't bring about radical changes in the way you use and consume energy and therefore are locked into emission intensive infrastructure in developmental (inaudible) and therefore one has to plan out how one can bring about a transition, if we have to mitigate the emission of greenhouse gases. Choices about the skill and timing of greenhouse gas mitigation and I'm talking in the global level, involves balancing the costs of emission reduction against the (inaudible) delay. If we delay taking mitigation measures, then clearly the impacts of climate change would become more severe over time and leading to balance against what would be the implications of mitigation, that means producing greenhouse gases today. Now here is an important table and I'd like to draw your attention to the first row over here, which says that if you want to stabilize these greenhouse gas concentrations say between 445-490 parts per million of CO2 equivalent, this will limit temperature increase to between 2 and 2.4 degrees Celsius, but if you're going to do that, then on the basis of our assessment CO2 emissions will need to peak by 2015, beyond which they will have to decline. But even with that, on account of global expansion alone, we would get sea level rise of 0.4-1.4 meters. So we're talking about roughly 1ft-4ft of increase in sea level as a result of thermal expansion alone. This doesn't take into account the melting of ice bodies at all. Now this is a pretty simple calculation. There are no uncertainties at (inaudible), because if you get this level of warming, then the oceans will become warmer. At the moment they haven't become warm all the way down to the lowest depths. It takes a long time for the oceans to warm, but when that happens then we get this level of sea level rise due to expansion alone. So mitigation efforts over the next two-three decades will have a large impact on our opportunities to achieve global stabilization. Hence if you want global stabilization levels in the future it's imperative that we start mitigation actions today. No looking beyond the (inaudible) the emission target to limit warming to 2-2.4 degrees Celsius would require developed countries to significantly reduce their emissions below 1990 levels or roughly 10-40% by 2020 and 40-95% by 2050. Developing country emissions need to deviate below their projected baseline within the next few decades. This means that developing countries will necessarily have to deviate from the path of growth of emissions that has been established by the developing countries, creating a very different future. However the good news is the cost of taking these actions is not high at all. We have assessed that if we look at the last line over here, to stabilize at 445-530 parts per million of CO2 equivalent, the costs to the world in 2030 will be less than 3% of the GDP, which amounts to 0.12% per annum and in 2050 it will be about 5.5% of the GDP. If we want to debate these two choices, lets say (inaudible) GDP without mitigation and assuming a

steady rate of growth, this is what we would get. But with the stringent mitigation measures, this is the way that line of growth would actually deviate. And what does this amount to? This essentially means that the level of prosperity that the world would attain in 2030 would at best be postponed by 7 or 8 months or a year at the most. This is the price, the highest price that the world would have to pay, to avoid the impacts of climate change, which naturally could be substantially higher. This is the kind of choice that we need to grapple with. Stringent mitigation would postpone GDP growth of one year at most over the median term. There are a lot of co-benefits of mitigation, co-benefits from reduced air pollution, because when you, for instance reduce fossil fuel burning, there's also a benefit in terms of improved air quality at the local level, which has substantial health benefits. There would be increased energy security, much more rural employment, because perhaps one would deploy more decentralized systems for providing energy. There would be increased agriculture production and reduced pressure on (inaudible) ecosystem due to increased troposphere ozone concentrations. The co-benefits of mitigation are therefore offset a substantial fraction of mitigation costs. So while I talked about the 3% loss of GDP in 2030 if you really count all the other benefits that go with it then 3% would be easily wiped out. So in other words it could turn out to be a win-win situation because of higher energy security, local benefits in terms of lower pollution and therefore larger health benefits and so on. Now we've also found that all stabilizations, or stabilization levels assessed, can be achieved by department portfolio of technologies that are currently available or are expected to be commercialized in the upcoming decades. So we really don't have to wait for any major breakthroughs in new technology development. We can start this action of reducing emissions of greenhouse gases through mitigation with technologies that are already available to us. But this assumes that investment (inaudible) and technology transfer and incentive are in place for technology development. So you need a policy framework which would drive producers and consumers in that particular direction. What other kinds of policies and practices are required? Appropriate (inaudible) infrastructure developments, research development and demonstration, changes in lifestyle management practices, I recall I was teaching in the summer here when President Jimmy Carter came up, I'm sorry that wasn't in the summer, no it was in the winter that time, when he appeared at the Carnegie and I loaned double stacks and appealed to all Americans to do that. Now that's a change in lifestyle which I don't think represents any great loss of benefit but I want to give you a little anecdote which I'm sure I could share in confidence with this distinguished group. Three years ago I was invited to (inaudible) Leadership poll, by the Secretary of the D.O.A. in Washington, D.C. I flew in that afternoon and there was a long line at immigration and by the time that I could get out, about an hour and a half had elapsed. There was a car that had been sent to receive me and this gentleman said "I thought you hadn't turned up, it's been a long time." I said "Well the immigration took a long time." He said "well, I've got a car for you, lets walk down there" we went along and this was a hot sunny day and I went there and I found the engine running and the air conditioner running. So I said "My God! Why did you have to do that?" and he said "Well I wanted you to step into a comfortable car." I said, "But you know, you probably had the engine for two hours. Was that really required?" So that's the kind of change in lifestyle that I'm talking about. It just means some attitude shifts, which when put together will really make an enormous difference. And that's what saying when (inaudible) practices, but what is absolutely

critical is to provide an effective carbon price signal. None of this is going to happen unless we have a price on Carbon. If we had a price on Carbon, then the world would be invested in research and development, consumers would go in for a low carbon technologies and I think you can bring about a shift in the economy quite effectively. What I want to emphasize is that the world is moving towards a low carbon future. I mean you've heard some of the proposals that the European Union is considering, Japan is going to follow suit and this will happen in many other parts of the world, even in this country you have some states which are clearly taking proactive measures. Now the world therefore is going to be a low carbon world. Companies that they believe will meet with success in both business and society contexts and those that don't lag behind will suffer from losses in the market place and loss of reputation, because we'll be living in a globalize the world and I think that if we read the writing on the wall, then I think it would make a lot of sense to invest in those technologies that are going to lead to a low carbon future. Some countries have been smart, they are already doing that. I know for a fact that (inaudible) spoke today and he's a good friends and I didn't have a chance to say hello to him today, but you know he's investing in nuclear imagination, but he believes, as he said, "I'm investing because green is green" it means you have green bucks because you are investing in green technologies. DuPont has made a major commitment and there are several other such companies in the world, because they realize that is where business interests will lie in the future. (inaudible) nations that show commitment to the growing global consensus would also be interesting in the future. Everyone wants to be part of the global consensus and I think leadership in these areas would carry a great deal of prestige. And those that (inaudible) would certainly lose very little power and influence globally. So I think that these are realities that we must understand and finally on a philosophical note I think all of us have to understand that we as human beings are part of nature. As Chief Seattle said "Man did not weave the web of life, he is merely a strand in it. Whatever he does to the web, he does to himself." I think we need to understand that and if we do, then clearly all these actions are really going to be in support of the ecosystems of this planet and to the benefit of the conservation of natural resources on this planet. So with this I'd like to stop and take questions. Thank you very much.

FEMALE CHAIR:

Thank you Dr. Pachuri and thanks again for making the trip. We'll take questions if I could just invoke the chairs prerogative on (inaudible) presentation to address the skeptics reaction to the fact that developing nations that haven't yet achieved a level of industrialization that we have, and I'm wondering also were they fit into the 445 parts per million, if that calculates in there already take in some level of industrialization. If you could address that please.

Dr. Pachuri:

I think that's a very valid question, but I do want to point out a few facts. If you look at the developing countries and then look at their terms, they have substantially lower levels of emissions. I mean ranging from something like one ton per person per year, which compare to 20+ tons per person per year in North America. It's also true that

there are 1.6 million people on the face of this planet that really don't have access to modern forms of energy or electricity and I think that developing countries, politically there's a huge challenge, you really cannot say that we will cut down on the growth of emissions without serving these communities and these societies. It's also unfortunate, but true that every human being living in a developing country is so overload by the dream that is so much a part of lets say the American way of life. Everyone wants to buy a motorcar, everyone wants a refrigerator and how do you thwart their aspirations and ambitions and say "Look you guys can't have this, that's only meant for the developed countries" So it's a real dilemma, but having said so I must emphasize that in the developing countries there is a need to deviate from the path that's been pursued by the developed world. But how does one bring that about? I think there's a need for much greater technology (inaudible) there's also need for practicing what you preach. And I think some major (inaudible) and some measure of action to bring about improvements in efficiency, some reduction in emissions, and therefore fossil fuel use in these countries is vitally important. Otherwise there is this growing suspicion in the developing world and I talked to one of the leaders over there, that the developed countries don't want to do anything. I talked to the Chinese and they tell us "Look, we're supplying all the supermarkets, and all the department stores in the U.S. with goods and services that are being produced over here, obviously we're going to emit more." Now that's a very (inaudible) kind of argument and I do realize that it's a one-sided argument. On the other side, I mean China is now so focused on creating economic growth and development. I've been traveling to that country since 1981 and I can't recognize the place. In 1981 everyone used bicycles; everyone wore Mau suits, drab grey clothing, which had no style or elegance about it. May General Mau's soul rest in peace if they ever did, but the result was that they are now embarked on a path of development which is a clear explanation of what's being done in the developed world. You can't go around anywhere on the streets of Beijing because it's a parking lot. There are so many cars over there and they're flooding the market with millions and millions of cars. So it's a real dilemma and I don't know what one can do about it. I think we really have to work together. I think we need to come up with some clear result to bring about change in the developed country and perhaps work and assist the developing countries to move on a path that is distinctly different from what has been established in the developed countries of the world.

FEMALE CHAIR:

Thank you. I realize that our country has to play a much greater leadership role than we have in the past. Thank you for that. Mr. Chair do you have a question?

MALE CHAIR:

You have told us about the work of the IPCC today, in the fourth assessment report. What can you tell us about where the IPCC is going in the future?

Dr. Pachauri:

I think what we're doing is currently carrying out a detailed debate. As a matter of fact I've drafted a paper which I have sent to all the governments of the world, to all the authors of the fourth assessment report, and the (inaudible) of the IPCC, to carry out a detailed discussion and debate which will be culminated in April when we meet in the city of Budapest, to see what the IPCC should do in the future. We would be very sensitive to what governments feel we should do, because I think we've reached a stage where we need to look at our record in the past and what the expectation of the world are for the future and then come up with a plan of action. So I expect in the next few months we will have much greater clarity in response to that question.

Mr. Wilson:

Thank you madam chair. You mentioned several key areas where North Carolina could study our vulnerabilities to climate change. One of the frustrating things for us as state climatologist, my role is to provide some kind of guidance on this, that the global models don't do a very good job of simulating the climate in the past of in the Southeastern general part of North Carolina in particular. So it's very frustrating to give good guidance as to what might happen in the future. Given that, what strategy would you recommend for us to identify our vulnerabilities and give good guidance for the global models?

Dr. Pachauri:

I think that there are now quite a few regional models which with some adjustment of data can be used within a regional context. I would submit that in three or four models could be used one can come up with the consensus on what is most likely to happen. Of course having lived here, I know North Carolina is a very varied set of ecosystems reaching right from the coastal areas to the agricultural regions and of course the mountains. So one would have to see what the impacts would be on each of these ecosystems. My own belief is that in the next two years or so one could come up with a fairly comprehensible assessment of the impacts, at least enough to give us some policy prediction and guidance. But this means mobilizing some of the academic and research communities in the state and perhaps even outside rather quickly, to come up with results as soon as possible.

Dr. Eggers:

Thank you so much for being here. One thing that's frustrating to me when I see presentations like this for example, with your slide on economics is that it only went out to 2030 and I think many things about that; if we have a globe stabilizing greenhouse gas emissions and greenhouse gas concentrations in the atmosphere that's in the neighborhood of 500 or 700 parts per million, we're really condemning future generations to a life beyond understanding, in terms of the suffering that we are committing as (inaudible) and I hoping you're nodding in agreement to that, and so its frustrating to me to see that 2030 number and not see it go up 100 or 200 years for the correlation of what concentrations of greenhouse gas that would result in because if we are willing to condemn future generations and not (inaudible) them, I think we have

impoverished the art of understanding already. Now I think this commission has a very profound responsibility and I think that as an environmental science professor that to talk about decreasing emissions and we need to talk about going carbon negative, if we're really going to be responsible about being stewards of the future and I wonder if you could talk about whether you think that's important and what we might do for that.

Dr. Pachuari:

First really, I submit that we've carried out assessment of tragedy is right to the end of this century and to be quite honest to go beyond that is really increasing the range of one's certainty. The reason why we focused on 2020 is because we feel that the global community must understand the urgency of action in the immediate future and also accept the fact that it's not expensive. I think our 2030 figure clearly establishes that. We also know that for the next 10-20 years irrespective of what scenario you pursue the increase in temperature would hardly vary, but where you really start seeing a difference and major deviation between the major scenarios and based on how much you stabilize that, it becomes much, much larger. Therefore I think it's critically important, and I agree with you entirely m'am, that we need to look at scenarios beyond 2030 and incidentally the fourth assessment report, perhaps for the first time, we've come up with a clearer linking and a clearing identification of temperature increases and the impacts that would occur with respect to water availability in terms of ecosystems, root security, so in other words its for the global community to decide whether 2 degrees centigrade is good enough or should it be lower. Now it really, and I always put this forward as a question, we thought more dangerous levels of climate change were dangerous for whom? If you talk to the small island developing states, they tell you they've crossed that dangerous threshold, if you talk to people in Bangladesh, a country with a huge coastline and so low in terms of height of above see level, that a single cyclone, a single storm surge causes a enormous devastation, thousands of people die, so much property is destroyed in a densely populated country, so if you talk to these communities across the world, they'll tell you that we're living in a state of fear. We cannot accept temperature increase of even two degrees Celsius, that's a bit much. So I think we really need to look at our responsibility, not merely to future generations, I would say this very generation, because climate change is happening today, it's not something that's science fiction in the future and therefore what I would submit is that we should look at the cost of actions that we could take and those actions are really not all that expensive. I believe that it is well within the capacity of human society with the economic, the technological path that we have to bring about a transformation. Some countries that were protected and are a very modest example of (inaudible). They have taken very proactive steps to world renewal in forms of energy, they haven't lost terms, they have added terms as a result. The economy in the last two or three years has been doing much better than it ever did before. So it really in a sense provides you with opportunities and then by doing all this you will be able to bring down prices of oil in the global market; much of the huge money that is going into other parts of the world, which if I may say so within the confines of this room, is not really being used for human welfare in any part of the world. In fact it's being used in several cases to create dangers that they are all subject to. So I think there is

a much larger focus in bringing about a major transformation and unless we start doing that today, we're going to really compound out problems into the future.

FEMALE CHAIR:

We have time for a couple more questions, but I did want to recognize a couple of distinguished guests we have in the audience today, Martin Riggor, who is the (inaudible) General in Atlanta. Thank you for coming and we have our distinguished Speaker of the House Joe Hackney with us today, former chair of this commission. Dr. Smith: Dr. Pauchari, I appreciate you coming here with us. This commission has struggled with what we can do at the national level and state level. You have a global perspective on this and you put up some slides about part of the reduction goals for reduction. Can you talk about for just a minute to us about the importance of what we should be doing at a state level and possibly (inaudible) state level goals that are concurrent with what we need to be doing at the national level.

Dr. Pachuari:

I can only come up with some suggestions because I would really need to study the situation at the state, which was my home coincidently, before I could come up with something specific, but first thing I must mention, is that we must understand the impacts of climate change. I think the sooner we do that the better, because to create the infrastructure, to create the institutions, and the mechanisms, by we might be able to reduce the risks to life and property the better it will be. Secondly I will submit that this being an agricultural state it would make a lot of sense to look at options by which you could use large quantities of biomass to produce energy. Of course, also, we have to be very careful that it doesn't in any way, infringe the ability of the state to produce food and food grains, because that in my mind would be a great mistake. For there are several other technologies that the state could work on that would really provide win-win solutions. Finally, I think it's worth the while of legislature and the executive branch government in the state to look at means by which you could place a price on carbon. Now I do realize that its very difficult for one state to take such a step, because you have to compete with the rest of the world, but there might be means by which you could bring about a transition by gradual, because over a period of time actually speaking, it would give the producers of goods and services in the state and enormous advantage to be, to get the first advantage of moving in that direction. One would have to clearly see which industries are likely to be hit by such a measure and therefore you certainly don't want to have them run into serious problems but creating a signal by which they innovate, by which they start moving in that direction. I think one needs a set of fiscal policies by which you can move the state towards a lower carbon pattern of production and consumption. Finally, maybe worldwide thinking of some industries where you might even lay down some benchmark standards and regulate them. I mean the building sector is one sub-sector. In my old institute I didn't have a chance to go and do that as constructive building, one of which is a trading complex that uses more power from the grid. We've designed a building in such a way that the demand for energy is 1/3 of what it would be in a conventional building and all of it has been linked to what it would take and a biomass gasifier that generates power and they use the energy in the earth, where four meters below the surface of the earth the temperatures are uniform throughout the earth. So we've designed four (inaudible) through which it (inaudible) comes into living spaces that gives you cooling in the summer and heating in the winter. So you know, I think the building sector is one area where one can bring about changes in terms of benchmarks, in terms of building codes, and some rare conditions by which you can shift to a much more sustainable future. So I think these some of these measures, if one could evaluate them, provide a pretty strong program of action in this field.

Mr. Buffet:

Thank you Madame Chair. Thank you Dr. Pachuari for your clear answers. I want to ask the question and I only want to ask an analytical approach (inaudible). You put up the mitigation targets for the developed world in your slides, those create a range of debate both in the United States and (inaudible) and in this commission significantly strived for this goal for the state of North Carolina about what is enough for us to do?

Each of those targets are 10-40 by 2010 and 40-95 by 2050, we have legislation in the United States Senate now that's in the middle of that. Some think it's not enough and so those of us who are trying to set goal and inspire some independent thinking about when do we act and when do we wait for a possibly even stronger program in the future? What would be your analytical approach here; what would be enough for this country to do in terms of action (inaudible)? How much do we need to act in the short term trying to wait two-four years and wait for a rosier picture.

Dr Pachuari:

I think that the U.S. has to be part of the next agreement, which is supposed to be is supposed to be finalized by the end of 2009. I would be very proud if this country took a leadership role. If the rest of the world is going to accept a part of lets say 20%, then the U.S. can be brought to a new percent. I think that the county cannot lose as a result, because as I indicated earlier, if the world is really going to be a low carbon world then the U.S. is really has to be able to forefront, not only to provide model and political leadership, but also to take advantage of market opportunities that will grow in the future. I can assure you that let's say the world agrees to 20% carbon in the next agreement by 2009 it's entirely possible that four or five years down the road people may come up with more stringent topics. So you really need to lead by example and I would say that the legal (inaudible) from the U.S. administration have to engage fully in what is happening in the (inaudible) natural process and I'm glad at least that they are now part of (inaudible) natural process, because a year or two ago there was a kind of disdain or contempt for what was happening under the U.N. framework convention in climate change and I hope it changes even more in the future. So I think the U.S. has to be a part of the next agreement.

Co-Chair Representative Harrison asks if there any more questions. Representative Thomas offers a motion: "I would like to make a motion that essentially is as follows: that this body adopt a basic premise for future work that, number one, Global Climate Change is indeed real, and further, that human activity is a factor in that change, and with that, we can move forward on addressing some of the issues that we have discussed here today and in previous meetings." Dr. Eggers seconded the motion and the motion passed.

With no further discussion, the meeting was adjourned.

Respectfully submitted

Representative Harrison
Co-Chair

Anne Misenheimer
Committee Clerk

APPENDICES

Exhibit A Visitor Registration Sheets

Exhibit B Agenda

Exhibit C Introduction of Dr. R. K. Pachauri

Exhibit D Climate Change
Dr R. K. Pachauri
Chairman, IPCC
Director-General, TERI

DRAFT
Global Climate Change Commission
March 5, 2008
643 Legislative Office Building
Minutes

Mr. Garrou called meeting to order at 10:15 a.m. and welcomed Ms. Sonya McKay and the 7th graders from Exploris Middle School here in Raleigh. Members present include: Mr. Garrou, co-chair, Representative Harrison, co-chair, Senator Albertson, Representative Thomas, Representative Underhill, Dr. Eggers, Mr. Tim Toben, Mr. Thomas Cecich, Ms. Susan Tompkins, Mr. George Everett, Mr. Preston Howard, Mr. Michael Nelson, Mr. Mitchell Peele, Mr. Daniel Phaneuf, Dr. Ryan Boyles, Dr. Stanley Riggs, Ms. Jane Preyer, Mr. Robert Slocum, Dr. Stephen Smith, Mr. James Stephenson, Dr. Godfrey Uzochukwu, and Dr. Pete Andrews. The visitor registration is attached as **Exhibit A**. The agenda is attached as **Exhibit B**. Mr. Garrou called on George Givens for remarks.

Mr. Givens: Noted that we have three basic items, a discussion of the Climate Action Plan Advisory Group or CAPAG recommendations and what we are calling a consolidated format. You may recall a couple of meetings ago we went through one of those five technical areas and after we got through that we thought it would be better to shrink wrap that presentation. So that is the effort today. At some point I suspect that there will be some desire on the part of some members of this commission to adopt some or all of those as recommendations or at least as matters to be considered for further work by this commission in terms of developing proposed legislation. That doesn't have to happen today. We have not yet received the final CAPAG report the Division of Air Quality is working on that we expect to hear from Mr. Peterson and that will be the main item of the meeting. He was flying in this morning and I expect him momentarily – we intend to start in just a moment with Bill Holman who is going to present on options from state and local governments to consider in regards to adaptation. We are beginning to look at adaptation as an issue and then we had a request from Mack Pearsall with the Center for Environmental and Climatic Interactions in Asheville for some time on the agenda to explain what they are doing up there. We expect today to finish by 1:00 at the latest – we have not scheduled a lunch break.

I call your attention to the two additional meetings that are scheduled and in particular to the April meeting which was rescheduled in light of other scheduling considerations. The co-chairs and counsel met recently for an extended period of time and have developed the following plan for the balance of this interim. As to the future of this commission, as the law now stands this commission is expected to file a final report to the 08 session and then terminate. In talking with various folks it appears that we are not going to get out of the problems we are in with regard to global climate change in the space of two to three years and so there is a perceived need for some continuing entity to deal with both the mitigation topic and the adaptation topic. The current thinking on that is to extend the life of this commission by one more year until the 2009 session at which time it probably would be appropriate to consider some restructuring and I'll be happy to entertain your ideas and thoughts about that. There are various considerations that are under review as to how a restructured commission might be constituted. I will tell you that one of the important considerations is that we do not want to lose the expertise that has been developed and demonstrated among all of those of you who are non-legislators. That matter is under review.

With regard as to how we are going to proceed, today as I indicated we are going to have those discussions of the CAPAG recommendations and some discussion of adaptation. We will continue to work on both of those topics and we expect to have the final report including a microanalysis by Appalachian State University. There is discussion underway as to whether the final CAPAG recommendations and their economic analyses should be developed as two documents or one and presented as one item or as two items – that is a CAPAG matter that is under consideration. We expect at the April meeting to begin to discuss whether the state should set a greenhouse gas emissions reduction goal and if so what that goal should be. The general thinking about the way those goals are expressed is to achieve with reductions and emissions so as to produce emissions for some historic level. The normal base year often discussed is 1990 and to achieve those reductions by some schedule that might be spread out to 2050 and those are not suggestions they are just a description. Behind that idea is the idea of holding the parts per million of greenhouse gases in the atmosphere to some number less than 500 on the order of 450. You can be thinking about that and we'll have some material for you and some discussion of that in April.

With regard to the specific area which is mobile source emissions we have had some requests by the Automobile Industry to present on that topic and also some possible discussion of clean cars legislation. That is the adoption of the California Motor Vehicle Standards for North Carolina. A number of states have done that – where that matter stands at the moment is that the USEPA has declined to grant California a waiver that is required under the Clean Air Act for those standards. That matter is now in litigation and is likely to be resolved early next year since most observers believe that the next administration is likely to take a different view of the current administration on that waiver.

Commissioner Choi has asked us to hear a presentation by Effery Electric Power Research Institute and we expect to do that as well. We hope by the April meeting to begin transitioning into May and to actually have an interim report.

Mr. Garrou: Any questions of Mr. Givens? If not we will begin the agenda out of order by asking Bill Holman who is the Visiting Senior Fellow, Duke University Nicholas Institute to give us his presentation.

Mr. Holman: Good morning – I appreciate the opportunity to appear before you and I'm going to spare you a power point this time. A handout is coming around (**Exhibit C**) and I want to try to be responsive to the Commission and bring you some options to consider, these are not recommendations, and I bring them in the spirit of starting a debate in our state about how we should approach a very complicated and challenging problem of adapting to our global climate change. Just a really broad overview – one of the things that is challenging about this issue is there is really no one in our state who is responsible for taking the lead in our state for preparing for planning for adapting to climate change. We don't have any goals, we don't have a plan. We have a lot of programs going on but there is not an overall goal or plan and that's the spirit of my options before your begin to throw out some ideas that might become a plan. Just in the way of background as Mr. Givens already said there are efforts underway. You know the countries and our country is trying to stabilize and reduce emissions of greenhouse gases. Despite those efforts we're still looking at the problem that will increase in greenhouse or in concentrations of carbon dioxide in the atmosphere of about 450 parts per million by 2050. So there is an urgent need for

strategies that you've been debating for many months to reduce the emissions of greenhouse gases but because of emissions that you've already occurred and will occur in the future - there is going to be some warming of the climate. It is now an appropriate time to begin these discussions. We've thought of this adaptation issue as something of the future but I would argue in fact that we are adapting now in a hap hazard way but we are adapting now to global climate change. Our citizens are investing in beach nourishment projects we're building a dike around Swan Quarter, we're paying higher property insurance, we're hardening the estuarine shoreline. There are a number of activities that are underway that are part of the adaptation to sea level rise and climate change that really is no overall plan but those hap hazard actions are occurring. We don't really have good North Carolina data to make predictions about climate. We've got these regional climate (inaudible) national and international climate models are pretty good about predicting the international picture but in terms of how the weather in climate is changing in North Carolina, NC State's ECONet program they've got 30 monitoring stations around our state. We also have 100 counties we have different elevations even within counties so we don't even have very good information about the specific changes in climate in different parts of our state. Some of the general theory about climate change is that the warmer air will hold more moisture and that should produce more rain which we obviously are not seeing this year but maybe that is the long term trend. But that rain may be delivered and more intense storms so that may cause us some challenges with more runoff, less groundwater infiltration and all the models we use for water supply for the design of our waste water systems for the design of our storm water structures for our flood plains – they are all based on historical weather data. There is a recent article in Science Magazine called Stationarity which that is a new word for me. Stationarity is dead with our water management is really talking about the challenges that water managers will have in the future because all of their calculations about how much water is in a reservoir and planning for the future is based on historical weather data. Since the climate is changing it may make it more difficult to protect precipitation, to protect lake levels and that's just a challenge that we're going to face.

Obviously how the weather also increases evaporation for water supplies stresses crops and landscaping and decreases the ability of warmer water in the summer to cool our nuclear and coal fired power plants and hotter summers can lead to unhealthful levels of ozone. Sea level rise is a big challenge for us as Dr. Riggs knows a lot more about this than I do, but we've got about 1.2 million acres in North Carolina that are below one meter or below about three feet in elevation and particularly vulnerable to sea level rise and storm surges. There is a recent study by scientists at East Carolina, Appalachian State, UNC-Wilmington and Duke that estimated that about 6.9 billion dollars worth of property in just four coastal counties is at risk from sea level rise. I know you've been debating about the cost of reducing greenhouse gas emissions, there are real cost associated with the impacts of global climate change. Here are some options to kind of kick off the debate – the basic one is just inventory and understanding the existing programs that were maybe not intended to adapt to global climate change but in fact have some bearing on that. So we have the Homeland Security, Federal Emergency Management programs, the Army Corps of Engineers involved in hardening projects and in beach nourishment projects, the Department of Agriculture does deal with disaster, there are programs in the Environmental Protection Agency, DENR, Crime Control Public Safety, we have a lot of existing agencies that are active in this field. Then there is no coordinated effort but I think it would be helpful to you if the next administration have a better sense for who is acting in this area and where the conflicts are between policies and programs so that we just have a better understanding of what's in play. There may be some barriers in programs or some things where the programs really need to be made more flexible – a program

needs to adapt so that it can play a role in adaptation, so inventorying existing programs. I would say we need to be thinking about developing and adopting some goals and principles for adaptation. Again our current situation is we got a lot of different programs they are not really set up with adaptation in mind but they are acting in this area and that will continue to happen until the governor and General Assembly sets some clear goals and principles about this. This is the direction North Carolina needs to take in adaptation these are the things that are important to us as a state and that will help guide other public and private decision makers. There are some other good tools – our Customary Management Act the Federal Coastal Zone Management Act have this thing called consistency in them as a way of better knitting together state and local and state and federal coastal management policies. Our state Environmental Policy Act can be amended to require our consideration of both emissions of greenhouse gases and as we're building new infrastructure, whether it's a wastewater treatment plant or sewer line or new bridge or highway, if sea level rise or climate change is going to impact that infrastructure, that needs to be taken into account because you build wastewater plants for 50 years. So again looking at some sort of clear goals and principles from the state I think is an (inaudible).

Improving climate data and research – we don't really have the information we need to predict the impacts of climate change, the droughts, the floods or the weather and then NC State has a great ECONet system but again it only has 30 monitoring stations in our state and cost about half a million dollars a year to make that statewide and maintain that. I think that will be valuable not only to folks working on adaptation but folks who care about drought and people who are working on water management. Lots of people depend on basic weather information and having more localized data would be beneficial and obviously you have an expert here in Dr. Boyles who can provide more information about the value of that monitoring network. We already have in North Carolina some great resources for climate research – there is the National Oceanic & Atmospheric Administration has the National Climatic Data Center in Asheville. Asheville is developing a Center for Environmental & Climatic Interaction that I think Mack Pearsall will tell you about later. UNC Chapel Hill is one of the leaders in the country in atmospheric modeling, Duke University has great expertise in the climate/energy policy and the emerging carbon markets and there is expertise on other campuses too. So I think there is an opportunity here for some more just basic research and data collection and sharing that with public and private decision makers. You can think about perhaps setting up a consortium modeled on the Water Resources Research Institute which is a public/private university consortium that funds water research in our state and has been very valuable.

We need to plan for droughts and extreme weather – we've always had droughts, we've always had floods but again the scientists are predicting we may have more severe or extreme storms in the future and there are some efforts already under way but I think it would be beneficial for the state to really direct the Department of Environment and Natural Resources and the State Water Infrastructure Commission to really work actively with the League of Municipalities, the American Water Works Association, the engineering community and others to provide the kind of technical and financial assistance that both public and private water, wastewater and stormwater systems are going to need. Again we are looking at hotter temperatures, droughts, intense storms and we need to make our water, wastewater and stormwater systems more drought and flood resilient. One of the things we've discovered in the drought is different communities use a different definition for safe yield – that is their way of predicting how much water they have and it really varies whether it is Raleigh or Durham or Charlotte or Asheville. The different calculations/different risk factors

taken into account – safe yield is a very fundamental concept in the water business it may be useful to have a consistent definition across the state so that when the governor is asking a city how many days of water they have left he or she has a good sense for making the same assumptions about that and again amending the Water Supply Planning Act and the North Carolina Drinking Water Act to provide a standard definition I think would yield to better planning. Also getting our Environmental Health agencies to know when they are reviewing water plans that is a good time to be asking how are you going to guarantee/how are you going to provide those water resources in the future, have you thought about the next severe drought and the same for the Utilities Commission.

Our Department of Crime, Control and Public Safety already has a good program called Storm Ready. It is a set of best practices that they worked with primary municipalities and counties on and that could be adapted into more of a climate ready. Again the same thing is we find a lot of mayors and commissioners are concerned about this issue but we are not really clear what we should be doing. The Department of Crime, Control if you use that existing program to build upon it you get people thinking about what they need to be ready for the future.

Planning for sea level rise and more intense storms – we already have a good fundamental planning tool in the North Carolina Coastal Area Management Act and it could be beefed up to require that sea level rise be considered in things like permit decisions and in local land use plans. We could increase protection of coastal wetlands and their ability to migrate inland. One of the great things about coastal wetlands is they are not only productive for our finfish and shellfish and they filter water pollution but there is actually some ability for them to grow as the sea level rises and they also provide protection for inland properties. We are loosing a lot of our coastal marshes because we are hardening the estuarine shoreline. We're building bulkheads and when the wetland hits the bulkhead there is no place for it to go so it just erodes away. This is a very challenging issue of the coast it has been debated for over a decade but I think it is time we really have additional public and thoughtful debate about this. We have some tools in the Coastal Area Management Act, the area of environmental concern where you can come up with some coastal wetland where perhaps the most significant wetlands can be protected. Obviously we will probably keep the seawall or the bulkhead at Beaufort and Morehead City and some of our coastal communities. So we have to make bouncing here but we do have some very important coastal wetlands and we have some tools to deal with it and it is just time to get on with looking at those tools. And the same for the ocean front – North Carolina has a model law to protect our ocean beaches, our model law recognizes that sea level is rising and that the barrier islands are moving and I think that has served us well in adapting to the sea level rise. We have an Albemarle/Pamlico Natural Estuarine Program and they borrow some information from EPA. EPA has something called a Climate Ready Estuaries Program again, those are some things that the states should consider for rising sea levels.

Maps and public information – if you wanted a map of sea level rise it is really hard to get if you were considered buying a piece of property. That is the kind of information we ought to make available to the public so they can be informed and make wise choices about development and land use decisions. There is an easy way to do that through our NC One Map program. We have a number of programs that are already kind of active in this area but they are not well coordinated and you can think about certainly improving coordination as a first step. You can debate whether it would be wise to consolidate our natural hazard planning and regulatory programs. Those

programs are principally in DENR and Department of Crime Control and Public Safety but we ought to take a look at how effective those programs are at either their technical assistance, educational program, their financial assistance, mapping, how well are those programs working and could they be better coordinated or would it be more efficient to do some consolidation. For example our flood plain management and stormwater management programs are in two different departments, they're complimentary and they certainly could be more effective if they were coordinated in the future.

Finally another idea is to put out for public debate is should we establish a North Carolina Hazard Mitigation Fund so that we can acquire conservation easements or fee simple properties that are in the flood plain or they are in high risk areas so we can protect the public, prevent property damage and lower risks before sea level rises and storms occur. That obviously would cost money and funding options would be appropriations from the General Fund or you could consider something like a fee on filling and floodplain or building in high risk areas or even a surcharge on property insurance. All of those are controversial I understand but there are some areas in the state that we know will be very vulnerable to sea level rise and storms and if we will want to move people out of harms way we will need to have some way to finance those efforts. With that Mr. Chairman I will be happy to answer any questions and if there are any of these recommendations the Commission is interested in carrying forward in the short session we would be pleased to work with your staff in drafting a proposal and I also think there are other good ideas out there on this issue and again this is in the spirit of let's start a debate about adaptation and let the good ideas come forward. Thank you.

Mr. Garrou: Thank you Mr. Holman. Questions?

Dr. Riggs: Thank you Bill that was very good summary and statement. I want to make a comment first and then ask a question. We have many different aspects of the state government that are moving forward with very critical issues right now as we speak. To continue business as usual out there in the coast and this underscores the absolute criticalness of the time of timing with respect to going ahead because these issues will block the barrier island coastal system up. Not just for the next 10, 20, 50 years but forever, the way we do business out there and for example the Oregon Inlet bridge by itself is not a problem but connecting it to Pea Island which is a collapsing island and going away and the total cost of 1.5 – 2 billion dollars before we're done to build a bridge road system to nowhere 25 years from now is not solving our problem nor looking down the road. We have in the next legislative session that will be one of the first items to come on the House of Representatives is a bill to start hardening and stabilizing the inlets in North Carolina. That's a very serious event and we can't sit by and let these processes continue with what we know on what is happening on the barrier islands. My question to you because we have so many different agencies involved and just helter-skelter sort of approach, is there any way we can put a moratorium on things like the bill that is before the Legislature in an effort to let this new sub-commission or whatever it is that Mr. Givens was talking about to get their feet on the ground and get moving with respect to how we want this coastal system to look 25/50 years from now. The military is already doing this – they're putting significant amounts of money to answer the question when sea level rise is one meter and two meter what do we have to do to maintain these bases forever and keep them operational. The state of North Carolina has to do that also and do it now.

Mr. Holman: On the question of a moratorium – is the General Assembly can act however it desires but I think to your basic point is unless there is an overall frame work plan or goal about how the state is going to adapt to global climate change we are just going to continue to make lots of piece mill decisions and they will be going in different directions. Some will be going in an adaptation direction and some will be going in a different direction and lots of public money at stake and private money at stake too. I think it would be to the benefit of the state to have an overall goal and plan for how we are going to deal with this. There will be some difficult trade offs – this is one of the most challenging issues I've ever started scratching the surface of.

Dr. Riggs: If I could just follow up then with the Chair and Mr. Givens, can this group make a recommendation to the Legislature as to how they should hold off on that particular bill until we get our heads around some of these ideas of hardening the shoreline. That's a pretty serious step right now that North Carolina is about to take.

Mr. Garrou: Absolutely we can do that – we will be making an interim report or we will be considering this among ourselves making an interim report to the Legislature for this short session and that can be one of the aspects absolutely.

Dr. Eggers: I just want to back up what Stan Riggs just said about hard stabilization and also beach Renourishment projects generally being such unwise use of taxpayer money to put it kindly and often is the case and probably a moratorium would be good. Sediment transport and all the long shore processes are complicated and it is hard for people to understand these but we should not run to stabilize our shores – that is not very feasible. Bill thank you for that presentation that was very good. When I think about what is going on at the coast and kind of business as usual approach and how fast houses are going up and I think all these should be at this point designed for this assembly or at least not maybe technically all the way designed for this assembly but designed in such a way that they can be taken apart and put on a truck and pulled back. That's what economically would be wiser – is there any place in here that would address US standards in terms of the recommendations from (inaudible)?

Mr. Holman: In the coastal area the Customary Management Act with the state and local partnership and actually when the Coastal Resources Commission adopted a rule in late 84 or early 85 banning sea walls at that time there was a little more room on the barrier islands. So there was a lot of moving structures back and because we've built out there, there are still some places where that are options but it is getting more challenging to retreat. Sea level is not just rising on the ocean front it is also raising on estuarine shoreline. Dr. Riggs knows more about the space available or the move of the barrier islands and that sort of thing. Those are difficult questions but if for example, you can generate maps that show if the sea level goes up a foot, here is what goes under water or here is what is more vulnerable to a storm surge and so you can identify more risky areas where property is going to be at risk and then you can begin to have that discussion on how do we respond to that. Do we have building retreat strategies or for some of our coastal towns, do we raise the seawall or something like that, not the seawall but bulkhead or that sort of thing. I think we need to begin the discussions about identifying those areas that are most at risk and then figuring out how we are going to respond. We will have to respond sooner or later and we would be better off responding with a thoughtful plan rather than reacting in a crisis like New Orleans is trying to do now.

Dr. Eggers: Your answer to this might be the same and if it is just say it is the same. It seems like one of the highest leverage approaches to really get the attention of public officials on the coast with regard to the need to do something in the very real impacts that this will have and even in near term would be to have based on inundation maps of eight inches a foot for them to have to make plans for what they will do in response to the loss of local tax revenues and other revenues and how they will handle that. Is there any recommendation here that would tie directly into that?

Mr. Holman: No but this is a list of options and you can add and subtract as the Commission (inaudible). But those are good issues that you raised.

Ms. Tompkins: Could some of this be addressed through North Carolina real estate law some of these problems of construction and deconstruction and titles and sellers and buyers conveying the right maps and surveys and so forth. In other words North Carolina real estate law can be dovetailed with some of the new mappings.

Mr. Holman: Yes and the General Assembly could decide to require that kind of information to be disclosed or again making the maps more widely publicly available so that again people are making important decisions and taking that risk into account. And that is not just through the coastal area we've got flood plains all across North Carolina and if we have more intense storms we may see more localized flooding as well.

Ms. Tompkins: And also the insurance industry could be involved in that. I think they need to dovetail with the maps.

Mr. Holman: Yes I agree and I think it would be wise to at some point engage the insurance industry to learn more about how they're taking these risks into account and again I hope they'll be a real benefit to a hazard mitigation fund and rules and regulations and those sorts of things so that our history is every time we have a large storm everybody's property insurance goes up. We can do things to minimize risk perhaps we can also minimize those premium increases in the future.

Dr. Andrews: Bill thank you for a very valuable start on an important topic here. I am struck by a couple of things – one is the need for measures that are both proactive and reactive. That is a number of these are directed toward improving our capacity to respond to the particular events that are likely to become more frequent; but others are really touching a much deeper challenge which is how do we plan for a world, a future economy and a future state in which more of these sorts of things are likely to happen. And so I am wondering if you can say a little bit more about how we develop the institutional capacity to do that because you've touched on several key sectors here – the coast everything that goes with the coast to begin with. But I'm wondering whether there may not be deeper issues also in agricultural planning, in utilities planning because the trade offs that I believe Duke Energy for example is already facing between the use of reservoirs for power purposes and to save and drinking water. There are a number of cross sector interactions and I was wondering if you could say a little more than just the state and Environmental Policy Act with all its promised but all its limitations about how we might tackle those sorts of questions.

Mr. Holman: That's a great question – I can envision a role for the Department of Commerce and the university system and outreach to the business community and planning. There are some sectors that will be a lot more effective by climate change than others but we are making sure our

folks are aware of the kinds of changes that scientists are forecasting. Certainly that is true in the agricultural area where we may need to work with our Department of Agriculture, NC State, A&T State. We may see some crop shifts or may need to do some more research on drought tolerant plants and that sort of thing. This is one of the most challenging issues I've began to scratch the surface of so I am sure there are far more implications here than I am prepared to address and I hope others will speak up about their concerns and the kinds of things whether it's a program or outreach that the state needs to put in place so we can get ready for this change in our climate.

Mr. Garrou: Thank you Mr. Holman for your presentation.

Mr. Stephenson: I wanted to mention that the Climate Action Plan Advisory Group also looked at this topic and came up with one of the subgroups of that, that looked at cross-cutting issues in its report, and this is something that is not shrink wrapped which is why I wanted to bring it to the full Commission's attention.. There were two preliminary recommendations that were made by the cross-cutting issues technical work group and a whole host of possible responses to any number of topics relative to adaptation including tropical storms, sea level rise, agricultural, forestry, fisheries, etc. The two preliminary recommendations I wanted to mention – one was to suggest that the General Assembly enact legislation to require sellers of coastal properties to disclose potential hazards to buyers, the coastal hazards disclosure should accompany all real estate transfers of property with ocean fronts, sounds or creek frontage in coastal counties. That is one that wasn't part of the presentation that Bill just gave us but I think it is one that's popped out during our interim report last year and the second is one that Bill did include, this last recommendation Bill referred to it as North Carolina Hazard Mitigation Fund. The recommendation of that cross-cutting issue group of the CAPAG was to create a coastal adaptation program that would be funded through a surcharge on the NC Beach Plan or some insurance surcharge. The funds would be targeted for the purchase of conservation easement on low lying coastal land but also for (inaudible) incentive with land owners for construction of ecologically beneficial for erosion control structures on estuarine shorelines which gets to a second recommendation that Bill brought forward. The problem that we have in North Carolina right now is approximately 30 miles of estuarine shoreline are bulk headed every year and that is an enormous amount of habitat that is lost to fisheries in our state. The other use of the fund the CAPAG cross-cutting issue group recommended was to use it for research to provide an assessment of the physical and ecological properties of the estuarine shoreline and potential cumulative impacts. I guess the one that pops out from the Institute for Environmental Policy Solutions report that they've shared with us today that I would like to see us bring forward as a priority is the establishment of a North Carolina Hazard Mitigation or Adaptation Fund and I hope that we will look at that more closely as we proceed.

Ms. Preyor: I thought Bill did a great job of giving a look at it and it jumped out to me but there are so many pools we have actually in place that we can target on this and that was very helpful and I would also note that it was a lot of focus on the coastal aspects of this and if we think more about presenting some ideas about a plan a sort of state wide look at adaptation that might include more of the land used and water supply issues that impact the Piedmont and west of our state, I think will be important to bring out too.

Mr. Garrou: Mr. Givens has a couple of things he wants to talk about.

Mr. Givens: I failed to mention several things. First of all, we welcome as a new member of this Commission Dr. Richard N. L. Pete Andrews. Dr. Andrews comes to us ex-officio as the designated Director of the Carolina Environmental Program at UNC Chapel Hill. Douglas Crawford-Brown designated Dr. Andrews before he stepped down. So we welcome Dr. Andrews to our Commission. He has a distinction among many distinctions of having been the adviser for Jennifer Mundt our analyst. I had contacted him and got a very favorable recommendation which has been (inaudible) out so he comes with a great deal of credibility. The second thing I will note is we are going to distribute to you at this time this document which is a prepared by the US Climate Action Partnership (**Exhibit D**). This is provided to us by a member of the Commission, Jane Preyor. Let me reiterate our policy about distribution of documents – it has been my practice to distribute all documents tendered to me with the request that they be distributed generally without comment. You are free to distribute things among yourselves but if you go through the staff, then they will become part of the record and we will make sure everybody has a copy. Lastly, I need to let you know that there is a lot of work going on across the country with regard of what the role of the state should be in climate change in the next administration. Several of us have been involved in those discussions and I thought you ought to be aware. For example, at the beginning of last week our co-chair Representative Harrison and Brock Nicholson from the Division of Air Quality and I were at the PEW Center for Climate Change meeting on federal and state regulations. I am also involved with an effort by the Rockefeller brother's fund. I took Secretary Ross's place at a meeting on that so he and I have been coordinating about that. That is another effort – Brock is also involved with one through the Air Quality Directors Association nationwide. The Air Quality Directors are in communication with the Rockefeller fund group that is basically leadership states. I am pleased to note that North Carolina is regarded as a leadership state among the countries on this issue. All of which is to say that there are a number of efforts underway to figure out what the role of the state should be and what the state should want from the next executive in the next congress in this matter. Be happy to talk further with any of you, thank you Mr. Chairman.

Mr. Garrou: Welcome Dr. Andrews to the Commission. And now we're back to the original order of the agenda and we'll ask Tom Peterson if he would give us the presentation on the CAPAG report.

Mr. Peterson: I believe there are two handouts (**Exhibit E**) available one is a table a couple of pages long and two slides per page version of the power point. It didn't reproduce the detail obviously but the full version has in it and we will be referring to that version on the screen and we will do a walk through that as we go through the table one piece at a time. I am going to walk through the power point and refer to the table as we go along so we just have one handout and the full power point on the screen. The request that I am responding to is a consolidation of the CAPAG options - there were 50 some but a long list that fell into a number of different categories and have been consolidated in a set of categories that relate to implementation initiatives and they have been aggregated and the related outcomes associated with them that we will measure as part of the CAPAG process have also been aggregated so we have a profile for each of these and we'll take a quick look at the profiles of these as well as the overall structure. We still have the full detail where all the individual options that exist in the report and some of the data that I'll show you but this is essentially a summarized version that is structured in the direction of implementation initiatives. They obviously remain flexible based on the judgments that this group would make or

others in terms of how best to structure this. So what I'm going to do is walk you through what we've put together and be happy to take questions and answers along the way if that's appropriate.

The categories that we've used for organizing the actions involved six major categories and if you count them up one by one, I think we've got nine, but the first category is heat and power and this is a combination of energy demand or demand side reduction actions on one hand and then supply side actions on the other hand. The demand side actions being called energy efficiency and conservation and the supply side actions called clean and renewable energy. These again relate to what sometimes is referred to as the stationary source sector residential, industrial and commercial but it is both the generation and the use of energy as well as other processes that occur in these stationary source sectors. The second flip side of that coin often called the mobile source sector – transportation and land use. A similar breakdown originally I had one single category for the demand side actions and then split that in two pieces because it seemed evident that they were both substantial enough and different enough that they deserved that. So the first category is location efficiency which deals with land use issues, development infrastructure, etc. Things that have the potential effect of reducing or depending on how it is managed increasing travel demand. The second is vehicle operations which relates to the design and the use of vehicles whether it is café standards, clean car standards, slow rolling resistance tires, etc. A series of actions oriented towards reducing the emission of greenhouse gases from vehicles during their operation. And the last category in this set relates to the use of fuel and its carbon content and this supply category for fuels includes things like ethanol for instance but it is a supply side category that's oriented towards liquid fuels used in mobile source sector. Those are the two big categories and then following them and based on the recommendations of the CAPAG are a couple of other key categories. The first being a collection of things that relate to agriculture and forestry – they are predominantly oriented towards land protection measures, whether it's restoration and recovery or protection from lost. There is a minor action included in that relating to soil/carbon buildup which we've labeled conservation practices but they've been lumped together. Just so you know, originally in looking at this we had structured this so that there were two separate categories, one for land protection and the second for conservation practices. In North Carolina there was only one option for conservation practices. It was rather small in terms of its scaling so we simply lumped that together in one generic category here. The next category is waste recovery and recycling which relates to either direct recycling of materials or recovery of energy from waste and reuse of energy.

The next category includes a couple of different actions in the state that we've labeled state and local government. We'll walk through that in more detail, but this relates on one hand to a series of information, education, outreach initiatives that the CAPAG group had identified. On the other hand a series of what we've termed planning and capacity building measures which relate to measurement systems and inventories report and registry as well as goals and targets. The final category is adaptation which is a separate track. Bill Holman has provided a very helpful briefing on some of the key issues there and as a parenthetical note on the adaptation recommendation that CAPAG has is a separate appendix in the report that maps that out in quite a bit of detail. These are categories that were structured really as a first step towards identifying what would be dramatically, organizational, institutionally logical initiatives that could be used for actual implementation. Obviously there are a lot of different ways that you could slice and dice and lump and split the recommendations that came out of the CAPAG process. I would say that this is a fairly typical rendition although it is a little bit different as it is in every state due to the unique

characteristics of the North Carolina process. Before we begin the walk through I sould ask if you have any general big picture of comments in terms of the structuring of this?

Representative Underhill: Thank you Mr. Chair. Will your power point be available to us online?

Mr. Givens: It is our normal practice to make documents available. We have a web page – we will try to post them.

Ms. Tompkins: Thank you Brock. Could you tell me what are the unique characteristics of the North Carolina process? Simply put.

Mr. Peterson: Sure. We're working in Iowa right now. Twenty-five percent of the emissions in the state of Iowa are directly attributable to agricultural practices. It is very different in North Carolina which is a much smaller number. In all likelihood in Iowa the percentage of reductions at the end of the day that will come out soil/carbon buildup practices will be very, very high. It's a low number in North Carolina. That's just one example – there are lots of differences substantially between the states – the mix of renewable, the level of efficiency opportunities that exist and those are very much reflected in the recommendations that came out of the CAPAG process.

Ms. Tompkins: What is the biggest one for North Carolina?

Mr. Peterson: The biggest in terms of?

Ms. Tompkins: Characteristic that is defining and shaping these categories.

Mr. Peterson: I would say the number one characteristic in North Carolina is in the category of being a high growth state. It is in the top tier of gross rates and emissions and that of course is reflective of growth rates in terms of the economy and population and etc. That changes the nature of both the problem and the potential solutions. It is depending on which measure you use which accounting system either 88 percent or 106 percent, but just roughly when you're knocking at the door of 100 percent growth rate through the 1990 to 2020 period that is getting into the top tier or the top third of the growth rates at stake. The low end you see a state like Pennsylvania all the way down to 13 percent.

The curves that you have in front of you on the screen is a color coded version and a label version of the supply curve that we shared with you at the last meeting. This is one that we've been able to tease out in more detail and categorize and each of the colors on this curve corresponds to one of the categories that we've seen on the slide before. This actually includes an earlier split out that we lumped back together that has the farm and forest conservation practices split out separately. It also has another category that we looked at that is not large in size but we thought might possibly be important for other reason which is state and local government lead by example actions. They are currently folded into the heat and power sector and the transportation sector but we did some pull outs just so you could see what that might look like. This is the same set of categories we went through on the slide before and you can see how they map out in terms of their importance to the tonnage reductions in achieving some total level of reductions and then you can see by looking at the left hand axis the estimated cost savings per ton. So again the height of that step corresponds to the price tag and the horizontal stretch of it corresponds to how many tons are

potentially available from that action area. This is a combination of costs per ton and supply potential in a stepwise cost function.

We saw the McKenzie supply curve at the last meeting as well. That is similar in structure and this is split out in steps the same way. I would also just note in the bottom axis we have a number of percentage numbers go from 0 to 50. This is the percentage reduction beneath BAU business as usual baseline emissions in 2020. So you go all the way out to the far right and at the 1990 level where we have an arrow that is approximately a 47 percent drop below BAU business as usual in 2020 and that would return North Carolina emissions to 1990 levels. That tops out on the high end at roughly $25 a ton. You slide back all the way to the arrow that says 2000 that is a 30 percent drop below business as usual and that would get you back to 2000 levels. In terms of the establishment of goals and targets they typically have been structured in terms of an index year say 1990 and then a future year and a percentage reduction target against that and so we see that here just for purposes of illustration I put 1990 and 2000. That can be converted to a percentage drop below business as usual which is the bottom axis there. We have not pulled together the benchmarks from other states in terms of the percentage drop below BAU. That is easy enough to do but they cluster somewhere below the low 30's to the high 40's. The low to upper 30's tend to be typical of northeast and west coast states the coastal economies and the higher percentage drops tends to be associated with higher growth states, primarily because of energy efficiency opportunities. Again two different ways to look at targets, the percentage you drop beneath the projected baseline and then the anchor point, the start year and then the index point that you need to get to beneath that. We are not going to spend a lot of time in terms of slide presentations, goals and targets but I did want to connect the dots in terms of the how mathematics of that are derived.

I color coded the general categories we went through earlier and profiled their total contribution to the reductions that were identified through the CAPAG process so you can see their percentage of importance just based on the greenhouse gas reduction potential. And going from the red bar on the left all the way to the green on the right you can see their ranking. The first two are in the heat and power sector, the first dealing with efficiency and the second dealing with the supply side issues. And we get into three bars that deal with transportation – the first is location efficiency, the second is vehicle operation improvements and then the third is the transportation fuels category. The next is land protection and conservation – the vast majority of which you will see in a minute is in the land protection and restoration category, then the final smallest category with waste recovery. These are aggregations of the options and certainly judgment calls have been made in terms of this particular format but this gives you some sense of the relative importance of these schematic areas. We also have information for their cost or cost savings per ton and that moves from left to right with the red bars going beneath zero that means the potential costs savings. The yellow bar going above zero which means potential net costs and we work our way across and see that we have the most significant cost savings opportunities on the efficiency side for stationary sources. And then vehicle operation improvements the judgment call by the group and we made an additional judgment call on location efficiency was partially quantified that we don't have a cost per ton figure here. Some qualitative decision that was made on some of the major issues they were to note that they are expected to have a net savings level that is significant but not fully quantified so on this slide we don't have a figure for location efficiency but it would be expected to be a savings.

Finally in this upfront profile we see total cost or cost savings estimated and I may have actually made an error in the 2007-2020 year and I think it is actually 2008 in term of the calculations that were used. But this is the net present value of either direct costs or direct savings associated with the actions in these categories. Some of them expected to achieve significant net savings others would involve significant net costs. I am not going to spend too much time on the next two graphs except to note that the supply curve, this is another rendition of the supply curve which is just cost per ton and all of the different options in the CAPAG can be placed on that curve and categorized so that the supply curve that we showed at the outset is a combination of this data. Then the next slide as well which shows the greenhouse gas reduction potential and individual options. Again they have been categorized but certainly important to note that the very first option here ES2 portfolio standard has already been the subject of legislative agreement and has been signed into law. In this analysis the option that is shown here actually is for a scenario that would go above and beyond that and it I think raises an important point to bear in mind as we go forward and that is the certain amount of actions has already occurred in the recent few months and it's likely to occur this year. We are seeing some reduction already of emissions in North Carolina either from federal or state action and that is likely to continue and be a factor in planning going forward. Just so you know some other key things that are not included in this analysis because of the timing of the CAPAG process – the numbers that we've developed do not include the impact of the recent federal energy legislation which includes some important energy efficiency measures. Incandescent light bulb standards effectively a phase out and the new automobile standards café some other key things and we're in the process of producing updates from recent federal actions and translating them into the impacts on the overall forecast of emissions for all states and including North Carolina. Clearly they will have a depressing effect on the overall growth rate but they are not included in what I'm showing you today.

The first category heat and power – what we see here is a yellow and a red wedge against the economy wide growth on emissions from 1990 to 2020 so you see very significant reduction potential associated with both of these areas. Again just to note, the portfolio standard has already begun implementation of a significant slice above because of the structure of that particular standard. We profiled the potential for the individual CAPAG options that are included in these two categories and label them so you can see what's inside the box and how that fits together. These are all schematically similar in terms of being demand side actions but certainly there are some differences between them. But this is what is what is in the red box if you will. Cost per ton cost or cost savings this is one that shows a number of cost savings measures that came out of the process the energy efficiency and conservation arena for heat and power. Again this is reflected in the summary supply curve we showed at the very beginning.

The next set are the supply side actions in heat and power which involve a series of actions that have been labeled here that deal with the reduction and emissions associated with the production of energy whether it is generation of electricity or direct fuel that are used for buildings manufacturing, industrial processes, residential use etc. The big ticket one that stands out on the far left is the portfolio standard. We have the cost savings profiled for this set it's a combination of a few that are expected to yield cost savings and others that are expected to be on that positive cost. We pulled out just for purposes of illustration to lead by example actions for - I believe these were state government as opposed to local government but they include both energy efficiency requirements for (inaudible) green power purchasing. Obviously, the design of these individual options varies depending on what they are – some are oriented towards public agencies and state

and local government and others towards the private sector. So this is just one illustration of being able to pull out one set of things that relate to one set of end use implementation. Cost per ton here again the efficiency measures expected to result in significant cost savings and the positive cost associated with green power purchasing.

The next category is transportation and working our way down from the top. The top slice is the fuels category, clean and renewable fuels, the next slice is vehicle operations improvements and the next one is location efficiency. Pretty significant when you add these up in terms of overall emissions reductions. The profile here shows big ticket items in terms of land use practices and (inaudible) transportation, etc. but it is a collection of very big items and then some smaller items. Then the cost per ton, the estimates here are potential savings and again there were some fairly significant discussion about exactly how to handle quantification for some of these so that's carefully worded in the text of the report and reflected in the numbers.

The next category which is improvements and vehicle operations shows on the left the California Clean Car Standards and Diesel Retrofits and a much smaller category with Idle Reduction. That first category is important to note that since the process concluded we've seen federal legislation paths for a new café standard and it was certainly the result in a portion of that set of estimated reductions happening under federal law. The estimated costs or costs savings associated with these, actually looks like this draft didn't work right, this is a repeat of the previous draft. My apologies, we are missing the costs per ton data but I can look that up. In the fuels category the graph is missing for that also. We can go to the data and get the profile on that as well.

The Farm and Forest Conservation category you see a blue wedge here that deals with land protection and you really can't see the smaller wedge dealing with soil carbon because it is so small which doesn't mean it is unimportant, it certainly was important enough within the CAPAG process to become a final recommendation. But the Land Protection category is responsible for roughly ten percent of the CAPAG reductions – this is consistent with national averages in terms of the estimated potential for terrestrial sequestration from these kinds of activities. A profile again we see on the left the forest protection, forest enhancement measures are much higher ranking than the bar on the far right which is the preservation of agricultural work land. Then the cost per ton is also high for that last measure of the agricultural working lands. So it happens to be one that is both low in potential and relatively high in terms of costs but again not necessarily indicating that it is not a priority.

Recovery and Recycling is a smaller wedge and deals with the combination of land fill methane and biomass energy recovery programs and manure digesters and then recycling infrastructure and collection. The first two are oriented toward waste energy recapture. The cost profile here shows pretty significant difference with the manure digester options. This may well be one that fits into the category of having significant co-benefits because of waste reduction and the process of setting priorities and making final recommendations. Co-benefits and co-costs were one of the design criteria and decision criteria that the group could consider and this is one where that was important. The final graph is just going back to where we started from originally in the CAPAG process which was looking at the approach to the working group structure and the policy actions by economic sector and we've rearranged that a little bit based on the actual outcomes of the process but it tracks roughly with the overall sector breakdown. Again, some differences a little bit more splitting and then you can see the relative magnitude of the CAPAG recommendations against

1990. The recommendations would not quite return emissions back to 1990 levels but relatively close. The table that we've put together as a back up for this provides the same profiling and a little bit more detail in terms it lists the specific CAPAG component actions that are in each of these action areas and the tonnage reduction potential costs savings cost and cost per ton. We've also added an additional metric year in response to a request that comes up very frequently which is an energy savings calculation and so we've listed that where it is applicable. You can see on the first item heat and power 1A Energy Efficiency and Conservation the estimates in terms of BTU's and giga watts per year, etc. That is one additional piece of information that we pulled out of the data in the full report. The final column here is a set of notes that relates to potentially key issues that would need to be considered in formulating either legislative or administrative action in implementing this action area. That is the overall brief.

Mr. Garrou: Thank you. Questions?

Ms. Preyor: Thanks so much for trying to pull this together in a new way for us to look at it. I just want to play back and see if I understand? If I say to myself, one of the questions that the Chairs have said to us, you know it's narrowing down, is this correct what your charts are saying that if I had to name the top four categories to get the most greenhouse gas reductions and how they relate to cost, is this what I heard that #1 in reductions and in costs savings is efficiency, #2 in reductions was the renewable energy but there were a lot of high costs on that one and that one is underway to some degree now; 3rd and 4th were transportation and the land protection category and they had a mix and a range of costs savings and ones that had positive costs and that the mix in there you can pick and chose on (inaudible). Is that a fair real lay person's look at that?

Mr. Peterson: Sure. This is a mixture but right off the bat in terms of where the tons are the stationary and mobile source sector, not surprisingly is where the tons are. And not insignificant are the tons that come along with land protection and conservation area but that is the short story on where the tonnage reductions are. The costs or cost savings map out generally but not exclusively following the man side reductions which is the net which is very important are the ones that show typically the highest potential for cost savings. The supply side actions are the ones that generally show some sort of positive costs. Obviously when you package them both together you are able to balance that out. The other important thing is that many of these options were structured deliberately anticipating that there would be integration within the sector of supply and demand side issues. So these were not envisioned as being entirely stand alone and one of the things we struggle a little bit with in putting this together was splitting out the demand and supply side for the sectors because they were really viewed in a much more integrated fashion in terms of actual implementation.

Representative Harrison: I don't mind asking stupid questions. Can we go to the last slide? I'm having a hard time understanding precisely what on the emissions reductions and you're talking metric tons of carbon emissions?

Mr. Peterson: These are equivalent so this would include not only carbon dioxide but methane (inaudible) and then the synthetic acids so this is all the gases that are recognized internationally and nationally.

Representative Harrison: So we don't have that translated into how it is going to work out as far as the parts per million, the 385 figure or their correlation?

Mr. Peterson: If the goal is to achieve 450 parts per million by 2050 or some point in the future which is certainly one of the recognized and now scientifically recommended benchmarks in terms of getting there from here. The question is whether any early benchmarks like 1990 levels by 2020 or 2000 levels by 2020 whatever it is, is on the pathway for stabilization for whatever that jurisdiction is. This is clearly on that pathway although if we were to stretch the right side of this from 2020 all the way out to 2050 you would see that this would need to go down fairly steeply in the arena of 70 percent maybe 80 percent reductions against 1990 or 2000 levels. So it would need to slope even further down but this is a pretty consistent level of effort in terms of being in a position to achieve the longer term reductions.

Representative Harrison: So that has a strongest reductions you mean?

Mr. Peterson: This kind of level of effort certainly has been viewed as consistent with that yes.

Dr. Andrews: Is there a background report that is available to us that that includes a little bit more of the detail about what specifically makes up each of the wedges? Each of these pieces clearly has assumptions behind it about how you achieve that full level that you are assuming we'll get to.

Mr. Peterson: If you will go to the project website for the CAPAG which is ncclimatechange.us the draft final report is posted with a series of chapters and appendices. They go into all of those details and the appendices contain the long form of the write ups for the individual policies and all of the details that was associated with that and that's many hundreds of pages but you can zoom in on any particular individual action and it is there. What we've got here is aggregated that detail, the write up is something a little bit more summary oriented.

Mr. Garrou: Dr. Andrews you missed the part where we got all the detail and asked for this. Other questions of Mr. Peterson? Thanks very much this was a good summary of what we've seen and I think this will be helpful to the Commission. Our next speaker is Mack Pearsall who is an Advisory Board Member of the Centers for Environmental and Climatic Interactions. Thank you for coming Mr. Pearsall.

Mr. Pearsall: Thank you Co-Chairs Garrou and Harrison for the opportunity to appear before the Commission. I am a member of a group of that called CC which is the Center for Environmental and Climatic Interaction and I provide user incentive for environmental and climatic interaction. It is a 501 C3 based in Asheville. You probably heard from me a month or so ago when we couldn't get on your agenda I sent you a CD about climate alive which really tells you a lot about what's happening in Asheville. But I want to bring it down to more of a street level and share with you what we're doing in Asheville and I want to bring you a proposal about how to get the water to the end of the road so to speak in terms of climate change and the measurement of particularly mitigation and adaptation opportunities for cities in North Carolina with Asheville potentially taking that lead. Now I am passing out a notebook here (**Exhibit F**) and I will simply direct first your attention to the cover of it which we see climate change, we've adapted to the fact that climate change is a scientific fact and we see this big red cloud over top of may the earth with somebody sleeping in quite repose and it is something that we've got to deal with. And we are going to

propose to you what I call the creation of the North Carolina Green Cities Plan. I am going to ask you in a moment to turn to the Executive Summary page and from then on I am going to direct you to the appendices and very quickly try to document the reasons we are proposing it. We went back and researched the basis for your being and under your duties and responsibilities I find under Section 5D an evaluation of economic opportunities for the state and they result in the international and national and state actions on to address climate change and emerging global carbon market. I am here today to talk about that so if you would turn with me to tab 1 and I want to tell you where we are in Asheville and why we are there. We are in the part of the state where we've lost tremendous number of manufacturing jobs. We've been trying to find a position in the 21st century that wasn't offshore that was authentic and was organic to us and the one that we could leverage with a sustainable competitive advantage and the Asheville hub was created as a catalytic group to find those particular opportunities. And we found a lot of opportunities another one we're working on beyond climate is the area rejuvenation and the integration of complementary and (inaudible) medicine which again comes back to part of what we're doing here in dealing with climate. What I am here to talk to you about today is what we're doing at CC in terms of this climate interaction. We realize we couldn't do it by ourselves so if you would turn to tab 2 and turn your notebook sideways and look at exhibit A. You will see that we have been building relationships with a lot of people and in fact I just came from Erskine Bowles' office. When I was there with the head of the NOAA operation here in North Carolina, NCDC I was there with people from Oakridge National Laboratory, I was there with all of Erskine's people who are planning their curriculum and looking for their graduate programs and all of that. We've got a relationships wherever you see a star in a box we already have an existing relationship with that. One of these you may well know about is the RENCI engagement site which comes through UNC-Chapel Hill. I'll talk about that as a way to anticipate and plan for interactions against catastrophes. But we've had to go to a lot of different places and we happen to have those relationships naturally in place – Oakridge is very close to Asheville. We already have an engagement with them through our AB Tech. The NOAA we have the National Climatic Data Center there and we have the US Forest Service. We are working at their special lab in doing a lot of research and modeling. We have a lot of private sector companies that are coming to Asheville to monitor weather and say how do you monitor it, how do you take it and turn it into something that is market driven that people want to buy the results of your information. And we think that the Department of Energy over at Oakridge and the Department of Defense in many areas have now been mandated to find out they have got to plan climatic interventions or climatic situations into their planning processes. We have a lot of local activities – well that's a relationship we couldn't do by ourselves.

Now the relationship we are talking about with you and what we are proposing, if you will go back to the first page and then we'll go to Appendix A1. We would like to propose to you this, the establishment of a partnership with the state of North Carolina, the University of North Carolina, the Nicholas Institute of Environmental Solutions, national foundations and others to develop and establish a North Carolina green cities plan to initiate test and validate climate change management initiatives and urban climate environment and to designate Asheville as that prototype place where it should be started. I'll give you the reason we think that which will help to solidify our position in the National Climate Change market. Now climate change is affecting everybody's life. What DOD is very concerned about it and when we're talking to people in Europe about moving vineyards north because they know they will not be able to grow grapes in a certain part of the world it affects everybody's life. Now what do we have in Asheville going on? We got the National Climatological Data Center that has six decades of records on daily information

coming in from all over the world and the United States about what's happening in climate. We have nine Noble Peace prize winners who are at the International Panel on Climate Change, the one for which Al Gore won his Nobel Peace prize, this intellectual capital that we find at Asheville and we plan to make use of that intellectual capital and the assets of NCDC and that data base there. Now there are people all over the world who are predicting tragic circumstances and the time to intervene is now. We believe also that the time is now to act because we know there is going to be a lot of federal money spent on research in the climate change area. We had the National Climate Change Data Users Conference in November and over 200 people were there. We had re-insurers, we had transportation people and we also had energy people. It is amazing how those people are concerned about what is happening in their industry. I never thought on transportation but I drove into that storm last night from Asheville and I don't know if you believe in climate change, whether it was coincidental or not but what they are telling us is we are going to get the same levels of precipitation but it is going to come in much steeper peaks like that and when spike in heating and fighting cold it will call early metal fatigue in bridges. Who would have ever thought about the climate change implications from that type of thing? We had that users' conference there and the market is going to be unbelievable. Now it is one reason we are all struggling with exactly how it is going to come about because it is a brand new market and there are a lot of unknowns in it. But we know there is a great desire for an honest broker of climate information. As an attorney I can tell you I can buy conversation and information expert testimony on either side of the case but I'm telling you these people are in industries where they are trying to make long term and capital investments and they don't want to be off the mark in making it. If you're going to give them that type of information you need highly sophisticated scientific input and you are also going to need different types of technicians. How big is the market? Right now it is a 2-4 billion dollar market; in ten years we think it will be a 10 billion dollar market in less than ten years and we think there will be a 500 billion dollar private sector spin off and that is where Asheville is trying to position itself.

Now if you will look back to the Appendices look at Exhibit B. These are predictions that have been made by our experts on the type of money that is going to roll out of this entire industry as a development – a brand new industry. The only thing that I would point out here is I don't understand all of the sophistication behind these formulas but at the bottom next to the last dot that says weather affects only 30 percent of the GMP but climate affects 100 percent of the GMP. Exhibit B, Appendix B is behind Section 2, Tab 2 and the Appendices are alphabetical. This substantiates what we think will be the gross of the industry and how much it is going to mean to a community that is trying to find a position in that market. We need to act now because there are others who are involved in this. Colorado is involved in this, Maryland is involved in it and others are attempting to get involved in the cold climate change management initiative and the management of that data. We've chosen specific markets for Asheville – one of our specific markets is to take climate change data and model it for public policy decision makers at the state and local level. This would be cities and counties that say what would this information mean to me in terms of what type of policies I should be initiating? Well if you look over at C and C1 in the Appendices you want to know why I say it should be done in Asheville.

We've been about it for five years folks, we've already had this HUB organization that's a catalytic organization, we've got the Center for Environmental and Climate Interaction because they already actualized our plan for North Carolina Aubrietrium and taking a lead in it we've got our own education research program going. We've got an applied visualization lab – our concept is that

people are not literate they're alliterate – they would rather see a picture than they had to see very complex scientific data and if you're going to convince people as a reason for change in the way they behave or to understand something from a policy standpoint, you are going to have to paint them a picture. We've got a growing media arts community that is basically our ability to merge the media artists with the computer artists and to convey that particular story. So we've got great opportunities going – we've not been asleep if you look at Section C1 Why Asheville should do it – why Asheville should be chosen as the boggy. If you will look here under C1 there are 78 reasons why Asheville should be chosen. You start off with our municipal situation where we are member of the cool cities agreement, one of the first people on the east coast to do that. We are members of ICLEI we are the only city on the east that has a Gold Leed standard for all of our municipal buildings. We've entered into carbon reduction agreements. We've got the (inaudible) engagement site with a decision wall and a completely immersive environment which we think is a new economy approach to teaching climate change and issues. We've had NOAA come in two weeks ago and said you are doing exactly with climate change information what you need to do to be sold to the market place. What we're doing is market driven – if you are familiar with GIS actives and (inaudible) the president of (inaudible) is very intrigued with what is happening in Asheville. He is coming to Asheville to see what we're doing because he thinks that type of information should be rolled nation wide.

We pride the greenest city but you are not going to find many cites in the state that are making eating utensils out of potatoes. We are in to all sorts of green things we have the Green Building Council We have our own American Green TV You Tube, (inaudible) Company that is started in Asheville. We have over 80 green buildings - the Biltmore House has initiated all sorts of green initiatives. We are home to the organic growers' school. We got an eco agents' deal for our realtors. Folks we are green and there are 78 reasons in there that will tell you why Asheville should be chosen as the place to initiate this plan. We haven't been asleep, look at D we've been planning this for years and it is finally coming to fruition. Even this morning as we speak, there is not going to be one National Climate Center, there is going to be a National Climate Services Network – Asheville intends through NCDC and through our civic efforts to make us a large node on that particular network and we're choosing visualization, policy making data and we are also have relationships with the Department of Energy and the Department of Defense. There is 74 million dollars in the federal budget, 3.4 million which is going to come to Asheville to manage a satellite operations program for earth observation. What is happening is the scientific part of this observation is over and now we need to move into the measurement of earth observation data for the purpose in terms of mitigation and adaptation procedures. So I come to the bottom and I say ok again we want to establish the partnership with the state of North Carolina, national foundations and others to develop a green city plan to test and validate management initiatives and urban climate environment and have Asheville designated to (inaudible). It is going to be a lot of snake oil, folks are going to be asked to do this and do that, we think we have the environment with the potential for the International Climatological Data Center to measure our intervention and validate it and be a place that people can come and be instructed on how to take the information that is in the academy and get it to the end of the road where it makes a real difference in real people's lives.

All that said, if you will flip over to Tab 3 I think there is a pit factor. I think it is a pit factor in Asheville and that it has a national bug about it and if you'll look at the PR pieces that we have behind there about how Asheville has become a venue for climate change. Our politics is liberal enough where we can undertake this type of thing and small enough and the last thing to be

designated as that particular city where we try the green cities program would fit us because that is what we are. We are sustainable and we live in that world. I was just given this morning out of Popular Science America's 50 green states. Greensboro is the last one listed on there the best one is in Oregon. They measure it in different ways from transportation to energy use to all sorts of other forms of reductions. What I say to you is we propose that we take all of the findings that you come up with and create an actual plan to get the water to the end of the road and we propose that Asheville will be that place and volunteer to serve with you and we have an action plan here. If you will look at Appendix F in item 3, the last thing in item 3, we are recommending that this Commission help us create the clean cities plan to encourage all cites in this state to work on reduction of greenhouse gases. We are hoping that you will encourage the Legislature to appropriate funds to create an urban green lab and that Asheville will be designated as that. We are committing ourselves politically to get our delegation behind it because we think that the science needs to be moved to the street where action can take place and we can change people's lives and change the impact through adaptation or through mitigation. That is our proposition and I hope you will do something with it. Put it in your records but we're here to let you know that we're a player in the climate change industry and we're already off and gone. We staked that territory out and we're actualizing on it and we think that in North Carolina if we're going to make a difference in the greenhouse emissions in the cities perhaps a green cities program would be the way to do it and we would offer ourselves as a candidate for that proposition.

Mr. Garrou: Thank you Mr. Pearsall. Questions? Thank you very much for that presentation.

Mr. Pearsall: Thank you and the books are being handed out and we'll leave extra books with the secretaries to give out.

Mr. Garrou: Before I open the floor for any discussion let me suggest to you what Chairman Harrison and I consider to be the agenda for the next two meetings. The first will be to consider whether and in what form to recommend a statewide goal for greenhouse gas emissions reduction. The second would be whether and to what extent to adopt the final CAPAG report as the position of the Commission. And the third would be to consider whether to recommend to the Legislature in the short session any particular form of legislation. The next two meetings in our view should be devoted to those three categories for action. Discussion?

Representative Underhill: Thank you Mr. Chairman and also Chairman Harrison. I think this is a point where we do need to seriously assess the information that has been provided to us and provide the Legislators who are serving on this Commission with a plan of how we want to proceed in the short session and then in the long term reinstating ourselves for another year for the long session where further legislation can be proposed. We have a lot of things that has been presented to us and I think we need to prioritize the key most vulnerable things that we need to do first. Since I fit in a district that may be under water some day soon from what I'm hearing I certainly am extremely concerned with the adaptation items we were presented today. But Dr. Riggs has said over and over and I would particularly want us to have some sort of strategy to begin to address adaptation and sea level change. I do not diminish the importance of all of these other things but we're really moving forward quickly the state is embracing the importance of greenhouse gas emissions on all the reductions of that waste. I don't believe that people in the state and even people in the east where I live understand the importance of what could happen in the next 50 to 100 years. With a very critically important economic driver in our state historically

and I really want to reiterate how important I think this is for us to concentrate in this first wave of information to the General Assembly what Dr. Riggs has brought forward today particularly with the piece of legislation that we will be faced with addressing immediately when we get there how do you deal with (inaudible). Thank you.

Mr. Garrou: Thank you – other questions or statements? If not we are adjourned and will see you next time. Thank you very much. Let me remind you to turn in your expense reports.

Meeting adjourned at noon.

Respectfully submitted,

Mr. John Garrou
Co-Chair

Thelma T. Utley
Committee Clerk

APPENDICES

Exhibit A	Visitor Registration Sheets
Exhibit B	Agenda
Exhibit C	Memorandum (Nicholas Institute for Environmental Policy Solutions) Duke University
Exhibit D	A Call For Action – Jane Preyor
Exhibit E	Draft Consolidated CAPAG Options – Tom Peterson
Exhibit F	The North Carolina Green Cities Plan – Mark Pearsall

The Alligator River Climate Change Adaptation Pilot Project

Climate change, caused primarily by the release of heat-trapping gases such as carbon dioxide, is literally changing the world we live in. Around the globe, temperatures are climbing, seas rising, seasons shifting. Global warming is changing landscapes, putting wildlife at risk and increasing the likelihood of drought, floods, storms, and wildfires. But ecological damage is not the only consequence of climate change; the human health and economic impacts are also potentially catastrophic.

Among landscapes vulnerable to the effects of climate change, few are in as precarious a position as North Carolina's Albemarle Peninsula. The Albemarle landscape is a study in balance, where water is as much a part of the landscape as the land itself. Global climate change, however, is upsetting that balance, and rising seas threaten to forever change this complex ecosystem of estuaries, swamp forests, marshes, and meandering rivers. The effects of climate change are already visible on the Peninsula: the region's peat soils are degrading quickly and natural communities are in retreat from saltwater intrusion. Unless something is done soon to protect the landscape and manage the inevitable ecological changes, we could well lose as much as a million acres to rising seas within the next 100 years. The two maps below show present conditions on the left and, on the right, the extensive areas that would be flooded by the most conservative projection of 32 inches in the next 100 years.





More than 540,000 acres on the Peninsula are currently under conservation protection as National Wildlife Refuges, North Carolina Wildlife Resources Commission Game Lands, North Carolina Coastal Reserves, and other preserves established by The Nature Conservancy, the Conservation Fund, the North Carolina Coastal Land Trust, and other private and public agencies. Albemarle and Pamlico Sounds are part of the largest closed lagoon in the world and the healthiest and second largest estuary in the eastern United States.

The effects of climate change threaten decades of work by The Nature Conservancy on the Peninsula. Although we must accept the virtual certainty that the landscape will change with the climate, this doesn't mean we are powerless to preserve its natural diversity and richness. In fact,

we can take steps now to make the Peninsula's ecosystems more resilient to climate change and to reduce the likelihood of catastrophic changes.

Executive Summary

With the help of Duke Energy, The Nature Conservancy is prepared to bolster the Peninsula's resiliency and mitigate the effects of climate change on the landscape. We have designed a multifaceted climate change program for the Albemarle that includes land conservation, habitat restoration, and a variety of science-based adaptation techniques to increase the ability of ecosystems on the Peninsula to adapt to changing climate forces. Ultimately, we aim to develop a comprehensive Albemarle Peninsula Climate Adaptation Program. Such a program would support ecosystems by maintaining their resilience in the face of extreme stresses originating with changing climate. The program would ensure that, as the ecosystems of the Peninsula are inevitably transformed by changing climate and rising seas, they are transformed into ecosystems that still support many species and complex natural communities, sequester large volumes of carbon, and provide human ecosystem services such as clean air and water, ocean and forest products, and outstanding outdoor recreation opportunities. The program would ensure that organisms that can migrate inland and upland have corridors through which to do so.

We propose to launch this program with a $3 million Alligator River Pilot Project and we invite Duke Energy to join the Conservancy in this undertaking. We request Duke Energy's consideration of a $1 million commitment, over a period of up to 5 years, to help establish the pilot project.

Conservation tactics will include:

- Hydrologic Restoration: restoring the hydrologic regime and associated wetland systems, primarily through mitigation and management of damages caused by artificial ditches;
- Land Restoration, Reforestation and Shoreline Transition: protecting existing natural habitat, especially inland and upland of current conservation lands in order to facilitate the movement of species as sea level rises; ensuring that shorelines are not subject to hard armoring and supporting living shorelines;
- Oyster Reef Restoration: restoring oyster reefs in Pamlico Sound to buffer shorelines from storms and rising seas; and
- Measuring and Monitoring Project Impacts on Carbon Sequestration: working with experts, develop strategies for establishing a baseline for soil carbon in the system and monitoring the effects of various management tactics on the gain and loss of soil carbon.

The Albemarle Peninsula Climate Adaptation Program will be the first large-scale, multi-factor adaptation program in the United States, each component of which will also sequester new carbon and/or prevent the loss of old sequestered carbon. The program will occupy one of the places in the world most threatened by climate change and rising seas. The Alligator River Pilot Project will focus on modeling, proving concepts, and implementing the two highest priority

regional strategies: hydrological restoration to control salt intrusion and oyster reef restoration to provide habitat and reduce wave energy—and thus erosion—in the near-shore environment.

Support from Duke Energy would allow us to immediately embark on the most critical conservation strategies outlined in this proposal, including work to control processes that will rapidly release soil-based carbon to the atmosphere. The Nature Conservancy would use a $1 million commitment from Duke Energy to leverage at least $2 million of additional private support. Public funds will also be sought to further leverage the private investment.

Mariah Matheson (Research)

From: Mike_Bryant@fws.gov
Sent: Thursday, November 13, 2008 2:29 PM
To: Mariah Matheson (Research)
Subject: Re: Presentation before the Legislative Commission on Global Climate Change 14 November 2008

Attachments: Proposal with carbon baseline stop-loss appendix - May 9, 2008.doc; pic12287.jpg


Proposal with carbon baseline ...


pic12287.jpg (5 KB)

Mariah,

I'll bring a power point on a jump drive and will load it with your help when I arrive.

My presentation's take home message:

The Nature Conservancy of North Carolina and the North Carolina Coastal Federation have been working with the staff at Alligator River National Wildlife Refuge to develop a management response to the effects of sea level rise. The refuge is in the lower coastal plain of North Carolina - it's predominately a unique swamp forest type called pocosins found on vast areas of organic soils. Keeping these carbon-rich soils sequestered and plant communities healthy would mitigate carbon loss. We know that the estuarine waters surrounding the refuge are getting saltier and we've seen with our own eyes shoreline loss and plant community changes on thousands of acres of this 24 year old, 153,000 acre refuge. Recently, we've been looking at refuge specific SLAMM (Sea Level Affecting Marshes Model) modeling data that says we'll lose up to 67% of swamp land and 90% of dry land by 2100 - that's most of the refuge.

The near-term management response seems deceptively simple - First, build resilience into the land and second, decide how to connect this land to other lands. We need to reduce salt water intrusion and to plant appropriate, salt tolerant native plant species like cypress.
Implementation is the big challenge - First, we need a plan that answers
questions: What kind and size of water control structures do we need and where do we put them? What species of plants do we need to plant, how many, where do we get them and how do we get them in the ground? Should we modify any of our current management practices? Where do we get the resources to get started?

Our partners are helping us identify where to start and they're working to secure funding to help us get started - they're trying to get money for a flashboard-riser/flapgate water control structure to be installed in a canal along Point Peter Road - a major inlet from the Pamlico Sound where we have evidence of shoreline erosion, salt water intrusion and plant community change.

It's only a start at trying to manage in the face of sea level rise, but it's good to know that we have partners who are willing to help. We encourage state agencies that have land stewardship responsibilities to participate. I encourage the continuation of this legislative commission and the development of an executive branch climate commission.

You find 11 NWRs comprising over 400,000 acres in this same vulnerable landscape - they are all within the same climate change induced sea level
rise "bulls eye". Since this is a landscape level issue, we're starting
to work with an ever enlarging number of partners to see how we can connect these refuges with other lands to give wildlife a place in the future.
Specifically, we're talking with the EPA's National Estuarine Program's Albemarle Pamlico Estuarine Study and

with a new entity called the Albemarle Pamlico Conservation and Community Collaborative to engage all citizens, organizations, and communities interested in this issue.

The following attachment is a proposal that North Carolina Chapter of The Nature Conservancy has presented to Duke Energy for the adaptation pilot project we are participating in.

Here's the proposal:

(See attached file: Proposal with carbon baseline stop-loss appendix - May 9, 2008.doc)

Let me know if this is enough or if I need to provide more information.

Mike

(Embedded image moved to file: pic12287.jpg) Mike Bryant, Project Leader
USFWS
North Carolina Coastal Plain Refuges Complex
P. O. Box 1969 (shipping: 708 N Hwy 64)
Manteo, NC 27954
office: 252-473-1131 ext. 222 cell: 252-216-7505
fax: 252-473-1668
mike_bryant@fws.gov

Bryant

Carbon on the Albemarle Peninsula

The Alligator River Climate Change Adaptation Pilot Project will have a wide range of impacts on carbon sequestration. Installing tide gates and selectively plugging or regulating ditches can reduce the impact of salt intrusion and maintain a level of soil saturation that would limit soil ignition during prescribed fires. If peat-based soils can be kept locally intact until they are colonized by salt-marsh as the sea rises, then most of these peats may be sequestered permanently beneath sediments trapped by the marshes.

Monitoring Carbon Stored in the Soil

We propose to document precisely the contemporary inventory of soil carbon on the Albemarle Peninsula and to establish a spatially comprehensive approach to monitoring the success of our soil carbon sequestration strategies. Initially, we will map peat lands using satellite data. We will also evaluate Ground Penetrating Radar (GPR) as a tool to map the spatial extent and depth of peat soils. Peat depths will also be measured manually with probes and cores along transects designed to be statistically robust. Soil bulk density and carbon content measures will provide accurate estimates of the carbon present in the system. Thus, TNC will be able to provide information about the carbon baseline in the soil and the effectiveness of conservation actions at preventing its rapid loss to the atmosphere. Control sites, where measures to reduce soil erosion were not taken, will also be measured in order to gauge the effects of our peat protection activities.

Measuring Carbon Stored in Protected and Newly Planted Forests

A permanent and statistically robust sampling strategy using permanent transects will document existing carbon in standing biomass and allow us to monitor changes over time. These data will allow us to establish a comprehensive inventory of carbon in standing biomass and to build, prioritize and implement land-cover restoration and conservation plans in order to optimize the carbon sequestration potential of the program.

With funding from the U.S. Department of Energy, the Nature Conservancy's Global Climate Change Initiative has developed a tool to estimate the expected carbon gains and the potential carbon revenue from reforestation and afforestation projects. In addition, the Initiative is collaborating with Winrock International to develop and refine new tools and technologies—including the use of aerial videography to estimate carbon in forest vegetation—for designing accurate and cost-effective carbon sequestration projects. As these new tools and technologies are refined, we will use them to ensure the most accurate measurement of carbon stocks in existing and restored forest lands.

Measuring Carbon Stored in Oyster Reefs

One of the benefits of oyster reef restoration will be the sequestration of new carbon in oyster shells as calcium carbonate. The baseline for carbon on new reefs is zero; we will develop a method to estimate carbon accumulation in shell as reefs grow.



NORTH CAROLINA

ASSESSING THE COSTS OF CLIMATE CHANGE

CLIMATE TRENDS IN NORTH CAROLINA

During the last century, the average temperature in North Carolina rose by 1.2° F, and precipitation increased by 5 percent in many parts of the state.[1] Although temperature and rainfall variations occur within the state, overall the last decade was warmer and wetter than the previous four decades. The maximum summer temperature has risen near the coast, and minimum temperatures have risen for all seasons throughout the state. During the past 50 years, precipitation increased during the fall and spring, but decreased during the summer.[2]

OVERVIEW
In the coming decades, a changing climate is expected to increase economic impacts on North Carolina and the nation. The most recent climate modeling predicts warmer temperatures, higher sea levels and more precipitation for North Carolina, and that these changes may be more pronounced if global emissions of greenhouse gases are not reduced. Climate change threatens state coastal infrastructure, agricultural productivity and drinking water supplies. Since the state economy is directly linked to those of neighboring states and regions, policymakers may wish to consider both state and regional policies to address climate change.

During the next century, climate models predict that temperatures could increase by 4.1° F (considered a conservative estimate) for the southeastern United States.[3] Increases in frequency and duration of extreme hot days during the summer also have been predicted for North Carolina.[4] Precipitation could increase by 15 percent in winter and spring and by a greater amount in summer. Despite the projected precipitation increase, droughts may become more frequent as higher temperatures accelerate evaporation.

Climate change also could accelerate the trend of global sea-level rise. The latest Intergovernmental Panel on Climate Change report estimates a 7- to 23-inch worldwide rise in sea level during the next century.[5] Rising sea levels could be particularly disastrous to coastal North Carolina because its shoreline is already sinking at 7 inches per century, so the projected increase will worsen erosion and land loss.[6] In fact, the National Assessment of Coastal Vulnerability to Sea-Level Rise, undertaken by the U.S. Geological Survey, found that more than half the state's shoreline is at very high risk to sea-level rise.[7] Climate change could further add to this risk by increasing the intensity and frequency of hurricanes. Fueled by warmer ocean temperatures, hurricane activity in the Atlantic may intensify; the strength, duration and frequency of hurricanes are predicted to increase due to climate change.[8, 9]

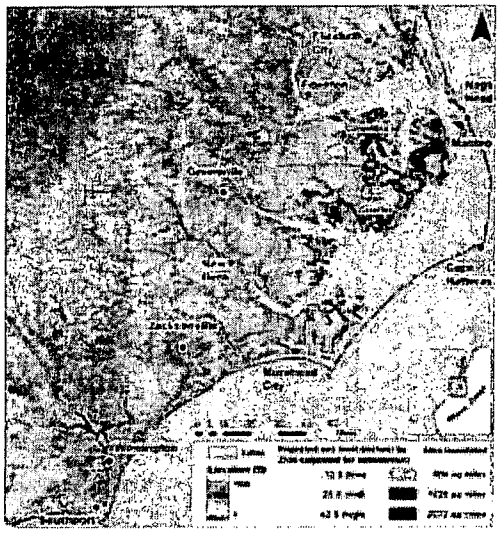
ECONOMIC IMPACTS[10]

Coastal Impacts

Sea-level rise due to climate change could have a major economic effect on North Carolina tourism, recreation and real estate. Many variables—such as regional coastal slopes, shoreline erosion rates and the shape of the coastline—determine a particular area's vulnerability to rising sea levels. Figure 1 shows the vulnerability of the North Carolina coastline to higher sea levels. The coastal areas shaded

in dark red are at highest risk to sea level rise; the lighter shades indicate the land area at risk from higher sea levels. More than half of the state's coast falls in the high or very high-risk categories.

Figure 1. Map of Coastal North Carolina and Sea Level[11]



Source: Poulter and Halpin, 2008.

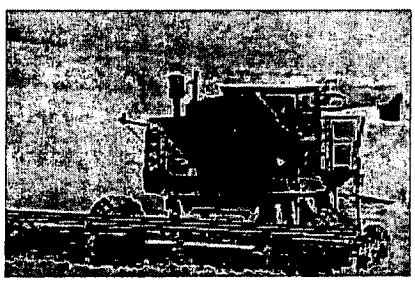
The rising seas threaten valuable property along the coast. In North Carolina, South Carolina and Georgia, the value of insured coastal property increased by 88 percent— $62 billion—between 1988 and 1993.[12] It is estimated that an 18 inch rise in sea level by 2080 would result in a total loss in value of more than $2.8 billion for residential and nonresidential property in four North Carolina coastal counties—New Hanover, Dare, Cataret and Bertie (see Table 1).[13] Increased real and perceived dangers of coastline loss and flooding also affect the cost for insurance coverage in coastal communities.[14]

Table 1. Estimates of Lost Coastal Property Value, 2080, 18-inch Sea Level Rise Scenario in Four North Carolina Counties

County	Residential Property Value Loss	Nonresidential Property Value Loss
New Hanover	$99 million	$35 million
Dare	$988 million	$1.42 billion
Cataret	$100 million	$183 million
Bertie	$5.45 million	$3.8 million

Source: Bin et al., 2007, converted to 2007 dollars.

North Carolina also is at high risk due to hurricane activity. It ranks fourth in the nation for number of recorded hurricane strikes; 50 hurricanes made landfall on its coastline between 1851-2006.[15] Hurricane Isabel, which hit North Carolina in 2003, caused nearly $200 million in insured property losses.[16] With climate change predicted to increase hurricane activity and intensity, North Carolina and neighboring states could see increased losses.



The tourism industry could be affected by higher sea levels and more intense hurricane activity, both of which erode beaches; more threatening weather also reduces tourist interest in beach trips. It is estimated that, by 2080, an 18-inch increase in sea level would cost the state tourism industry up to $10.6 billion in today's dollars.[17]

One proposed method to protect coastal infrastructure from rising sea levels is to build a coastal seawall or bulkhead. Officials commonly estimate the cost of such a structure at approximately $1,190 per linear foot.[18] Building a seawall along North Carolina's 301-mile coast could cost the state $1.89 billion.[19]

Agriculture

North Carolina's agriculture sector also could be affected by climate change. Droughts, an increase in severe weather and higher temperatures could severely affect the farming, livestock and forestry industries. An AEI-Brookings Joint Center for Regulatory Studies report estimates a 22.6 percent climate-change induced loss in agricultural profits for the state.[20] North Carolina ranks second nationwide for hog production; nearly $2 billion was generated in cash receipts in 2006.[21, 22] Heat stress can reduce animals' ability to gain weight and reproduce, and temperature increases influence availability of forage areas. Research shows that a 9° F increase in temperature reduces livestock yield in animal and dairy operations by about 10 percent in the Appalachian region.[23] Since poultry and eggs comprise 36 percent (nearly $4 billion) of total farm sales, higher temperatures could contribute to significant losses.

The projected increase in severe weather caused by climate change also could threaten the agricultural sector. In the 10-year period between 1996 and 2006, 14 tropical storms and hurricanes caused agricultural damages totaling $2.4 billion in North Carolina.[24]

More severe tropical storms and hurricanes also could affect North Carolina's forests and forestry-related industries. Hurricane Fran, a 1996 Category 3 storm, damaged approximately 8.3 million acres of state forest land at total estimated cost of $1.7 billion. For every increase in storm category level, forest damages have been found to rise by approximately $500 million.[25] Furniture and related manufacturi industries that rely on the forestry sector are an integral par of North Carolina's economy, contributing $3.1 billion in 2005.[26] Climate change could affect the forestry sector by

undermining important economic engines, such as construction and manufacturing.

Public Health

Higher temperatures caused by climate change could diminish air quality in North Carolina and increase health care costs. Higher temperatures contribute to the formation of ground-level ozone and smog, which can worsen asthma and other respiratory conditions. The American Lung Association ranked the Charlotte-Gastonia-Salisbury metropolitan area among the top 20 most ozone polluted cities in the United States.[27] Asthma already is a serious public health issue in North Carolina, costing the state and its residents $631 million in 2003. Higher pollution levels caused by rising temperatures could increase social and economic costs due to higher levels of hospitalization and treatment for those with asthma and other respiratory diseases.[28]

Water Resources

Climate change could create water shortages due to coastal flooding and saltwater contamination of the freshwater supply, and also could increase the likelihood of water shortages due to higher temperatures and increased evaporation. More than half the state's population depends on ground water for drinking, and about 98 percent of all public supply systems rely on ground water.[29] Water use restrictions during the 2007 drought affected 53 percent of public water systems and a total population of about 5 million.[30]

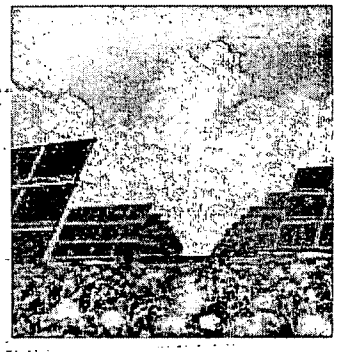
Increased drought severity and the probability of heavy precipitation could increase runoff and flooding, since drier soils do not absorb water so readily. More runoff and flooding can wash pesticides, fertilizers or other pollutants into water resources, creating higher levels of contamination and increasing water treatment costs.[31]

Sports and Recreational Activities

The North Carolina ski industry and related businesses generated approximately $120 million in revenue and employed more than 100,000 people during the winter of 2002-2003.[32] Climate models have consistently predicted a decrease in total number of skiing days during the next century.[33]

Wildlife-associated recreation, another popular activity in North Carolina, supports approximately 55,500 workers. In 2006, 3.4 million people spent nearly $2.7 billion on this tivity.[34] Climate change could alter habitat, affecting both ldlife populations and related industries.

Conclusion



North Carolina is likely to face large challenges in adapting to climate change along its coastline, since this is where the most significant economic and ecological effects are likely to occur. Protecting coastal developments and natural habitats—which will face increased risk of erosion from higher water levels and more intense storms—will be a leading concern. Since some sea level rise and climate change is likely regardless of efforts to reduce greenhouse gases (the long life of excess greenhouse gases already in the atmosphere make a certain degree of warming inevitable), it may be prudent to make adaptations to coastline development and habitat protection plans. Planners also may wish to improve flood response plans and adjust coastal development patterns to reduce community exposure to coastal flooding, erosion and storms.

An improved assessment of the effects of local climate change on freshwater supplies for drinking and agricultural uses will help plan for potential water resource changes. Since flooding is likely to be more intense when it occurs, planners and policymakers may wish to create assessments of those areas most likely to be affected so that flood response plans can be modified and mitigation measures can be taken.

Missing Information and Data Gaps

Much more information is needed, including:

- More detailed analysis of crop yields and productivity value due to counteracting effects of increasing temperature and decreasing water availability.
- Detailed analysis of effects on transportation infrastructure.
- More information on effects of climate change on state energy demand and use.
- Full economic effects of climate change on state ecosystems in coastal and mountain regions.
- Vulnerability of urban infrastructure (buildings, electric grid, sewage and water pipes) to climate change.

NOTES

1. U.S. Environmental Protection Agency, *Climate Change and North Carolina* (Washington, D.C.: U.S. EPA, 1998); yosemite.epa.gov/oar/GlobalWarming.nsf/UniqueKeyLookup/SHSU5BUTX6/$File/nc_impct.pdf.

2. R. Boyles and S. Raman, "Analysis of climate trends in North Carolina (1949-1998)," *Environment International* 29 (2003): 263– 275.

3. V. Burkett et al., *Potential Consequences of Climate Variability and Change for the Southeastern United States*, Report by the National Assessment Synthesis Team for the U.S. Global Change Research Program (Cambridge, U.K.: Cambridge University Press, 2005): 137-166; www.usgcrp.gov/usgcrp/Library/nationalassessment/05SE.pdf.

4. U.S. Environmental Protection Agency, *Climate Change and North Carolina.*

5. J.H. Christensen et al., *Regional Climate Projections* (Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the IPCC [S. Solomon et al. (eds.)] (Cambridge, U.K.: Cambridge University Press, 2007), Chapter 14; www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter14.pdf.

6. A. Munger and M. Shore, *Understanding global warming for North Carolina: Sound science for making informed decisions* (Washington, D.C.: Environmental Defense Foundation, 2005); www.environmentaldefense.org/documents/3053_NCClimateReport.pdf.

7. E.R. Thieler and E.S. Hammar-Klose, *National Assessment of Coastal Vulnerability to Sea-Level Rise: Preliminary Results for the U.S. Atlantic Coast* (Washington, D.C.: U.S. Geological Survey, 1999); pubs.usgs.gov/of/1999/of99-593/pages/res.html.

8. J.H. Christensen et al., *Regional Climate Projections.*

9. K.E. Trenberth, "Warmer Oceans, Stronger Hurricanes," *Scientific American* 297, no. 1 (July 2007): 44-51.

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ECONOMIC AND ENVIRONMENTAL COSTS OF CLIMATE CHANGE

OVERVIEW

The earth's climate is changing, and some states are beginning to see the effects—an increase in extreme temperature events, lower water levels in lakes and streams, and increased forest fire risk are a few of the visible signs. National Air and Space Administration (NASA) research shows that the eight warmest years (globally) on record have occurred since 1998[1] and predicts that summer high temperatures in the eastern half of the United States are likely to rise by 10° F by 2080.[2] These changes are likely to affect state forest, agriculture, tourism and water resources. These reports incorporate the latest scientific research to provide policymakers with a solid understanding of how the changing climate could affect their state, and how future changes will impact its economy, environment and people.

State and local decision makers play a critical role in developing and investing in sectors—such as water, energy, agriculture, tourism, forestry, transportation and public health—that are likely to be affected by climate change. These reports build on research by the Center for Integrative Environmental Research (CIER) at the University of Maryland, which explores how climate change could affect the economies and natural environments of states throughout the country. The research highlights the importance of planning for the possible effects of climate change on state natural and economic resources and explores options for reducing these effects.

INTRODUCTION TO CLIMATE CHANGE

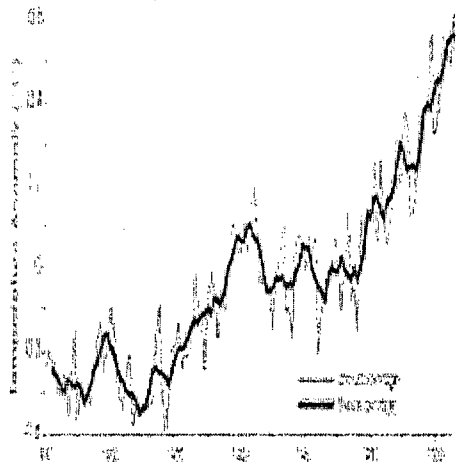
Most of the nation's most prominent scientific bodies support the conclusion that human activities have been the dominant force driving the warming trend of the past 50 years and that the earth's climate will continue to warm throughout this century.[3] The list includes NASA, the National Academy of Sciences,[4] the National Oceanic Atmospheric Administration (NOAA)[5] and many others.

Global temperatures have risen about 1° F over the past century (see Figure 1). Figure 2 illustrates how different emissions reduction scenarios could affect temperature increases by 2100. The global average rise in temperature—according to the best available models—is projected to be between 3.2° F to 7.2° F. Many scientists think that an increase greater than 3.2° F could have catastrophic effects, such as reaching a tipping point where warming accelerates, causing dramatic sea level rise, land loss, declines in food production and other serious negative outcomes. To avoid this scenario, models indicate that global greenhouse gas emissions should be reduced by about 80 percent by 2050 (see line B1 in Figure 2).

WHAT IS THE GREENHOUSE EFFECT?

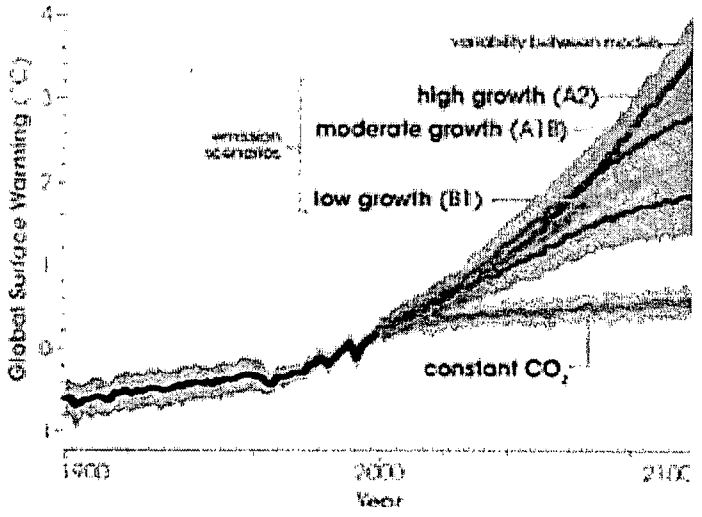
The earth is abundant with life due to the blanket of greenhouse gases that trap some of the sun's energy and allow the rest to escape into space. Without this blanket, temperatures on earth likely would be similar to those on the moon, varying from 280° F below zero on the dark side to 260° F on the side facing the sun. Human activity has changed the composition of these gases that reflect heat back to earth, increasing the amount of energy that is trapped. The result has been a global change in climate. According to research by the European Project for Ice Coring in Antarctica, atmospheric carbon dioxide (CO_2)—the most abundant greenhouse gas—is at its highest concentration in at least 650,000 years, with much of the increase appearing in the last 100 years.[6] Other important greenhouse gases—methane (CH_4), nitrous oxide (N_2O) and chlorofluorocarbons (CFCs)—also saw unprecedented atmospheric increases during the past century.

Figure 1. Global Surface Temperature



Source: NASA http://data.giss.nasa.gov/gistemp/2007/, 2007.

Figure 2. Emissions Reduction and Temperature Increases



Source: NASA Earth Observatory, 2007.

Options for State Policymakers

States nationwide are implementing policies to address climate change—17 have greenhouse gas reduction targets, and five have made these targets enforceable. These states aim for a 50 percent to 80 percent emissions reduction by 2050. California, Oregon, Massachusetts and Washington are requiring power plants to meet greenhouse gas emissions standards, which will help the states meet their reduction targets. Twenty-five states have implemented renewable portfolio standards and many have passed renewable energy and energy efficiency incentives. Analysis of state policies that reduce greenhouse gas emissions—such as renewable portfolio standards and energy efficiency—have not been found to substantially affect electric rates, and energy efficiency has been found to save ratepayers money in most cases. New Jersey has projected that its greenhouse gas reduction plan will provide a net economic benefit. States also are creating incentives for nuclear energy and carbon sequestration from coal-fired power plants as greenhouse gas reduction options.

The least cost approach to reducing greenhouse gas emissions and meeting energy demand usually is energy efficiency. Businesses, consumers, state governments and industries find that energy efficiency investments return money by reducing energy consumption. Since buildings account for approximately half of U.S. energy consumption and greenhouse gas emissions, energy efficient building codes, green building requirements and retrofit policies are popular state options. Policymakers also are addressing greenhouse gas emissions from transportation and industry, the next largest contributors of greenhouse gases after buildings.

Minnesota has seen returns of $3 for every $1 spent on its energy efficiency programs. The state recently passed a law that requires its utilities to meet 1.5 percent of demand each year through energy efficiency. These efforts are predicted to meet state energy demand growth, while the state's renewable energy standard of 25 percent by 2025 will reduce dependence on energy generated from fossil fuel.

California is considering requirements that all new residential buildings built after 2020 and new commercial buildings built by 2030 consume no more energy than they generate. These "zero net energy" buildings, which have been built since the 1980s, incorporate highly energy efficient designs along with on-site clean distributed generation—such as solar or wind power—to satisfy energy needs.

If and when Congress enacts national climate change legislation, the states that have developed climate-friendly technologies and energy resources may have an advantage. States that are leading the way in creating policies now may also have more leverage in influencing the federal debate.

Since information about the localized impacts of climate change is still lacking, states may wish to promote research that will more accurately predict potential changes at the regional and state level. Detailed assessments of potential climate outcomes and how they will affect various industries and ecosystems provide policymakers with the knowledge to create effective policies that will help the state adapt to changes while protecting its economy. Since climate change touches on many sectors, identifying and analyzing costs of inaction and policy implementation will be essential to creating effective policies.

The following conclusions can be drawn for all states.

- Although, these reports focus on the potential economic outcomes that changes in state climates may bring, the changes seen already have produced significant costs in some states. These have arisen from the changing climate's influence on infrastructure, agriculture, forestry and other sectors. These costs are likely to increase if greenhouse gas emissions are not significantly reduced.

- The effects of climate change should not be considered in isolation. Every state's economy is linked to the economies of surrounding states as well as to the national and global economy. Since state economies are directly linked to the economies of neighboring states and regions, policymakers may wish to consider both state and regional policies to address climate change.

- More information on the localized effects of climate change—including its impacts on water resources, ecology, health and natural resources—is needed to improve state mitigation and adaptation strategies. Better data on local outcomes would improve estimates of economic effects that climate change will have on a state.

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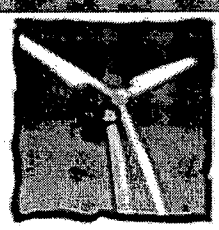
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NC Global Warming Cornerstones

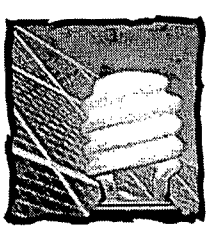
Legislative Commission on Global Climate Change

November 2008

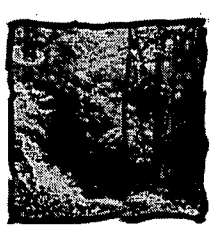
Overview



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Energy Efficiency



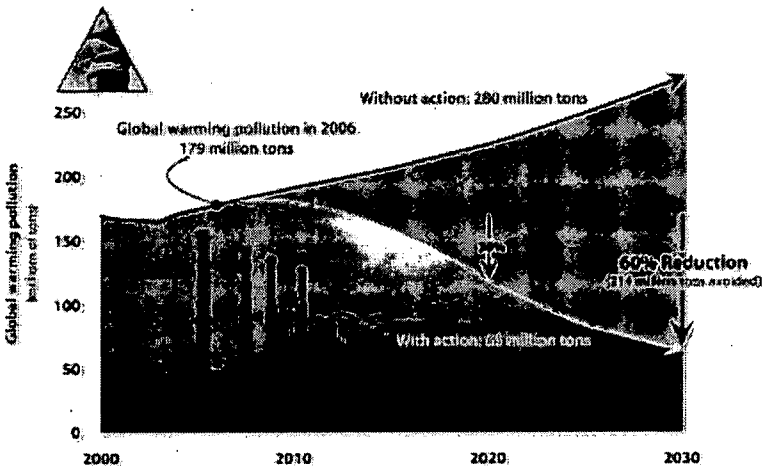
Pollution Capture



Long-Range Planning

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Goal: 60% Reduction by 2030



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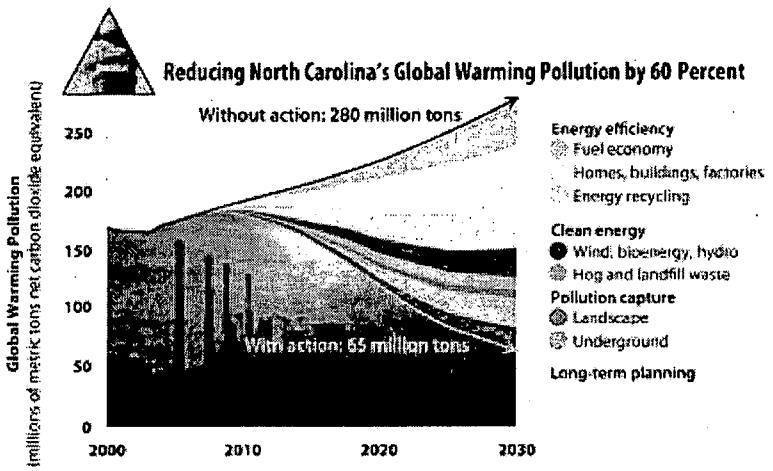
CAPAG ↔ Cornerstones

Year	CAPAG (million tons CO_2 equiv.)	Cornerstones (million tons CO_2 equiv.)
1990 – actual	136	n/a
2000 – actual	180	170
2010 – forecast	215	192
2020 – forecast	256	226
2020 – with policies	137	119
Reduction vs 2000	*24%*	*30%*

- *Cornerstones* draws on the CAPAG report, but includes updated data.
- Updated data and other adjustments resulted in lower emissions growth.
- *Cornerstones* urges somewhat more rapid and expansive policies.

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Energy Efficiency: Highest Priority



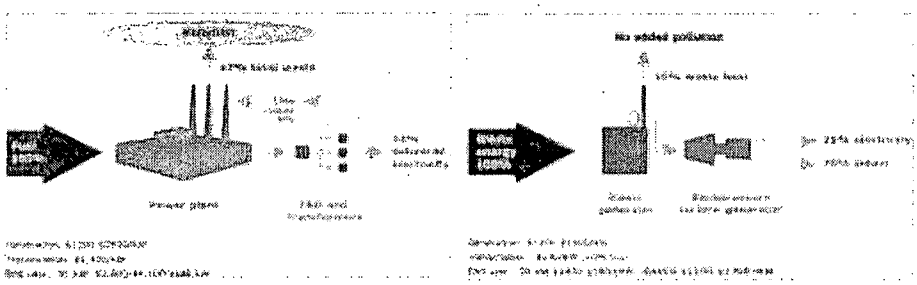
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Energy Recycling

Conventional Central Generation

Recycled Energy (at user sites)

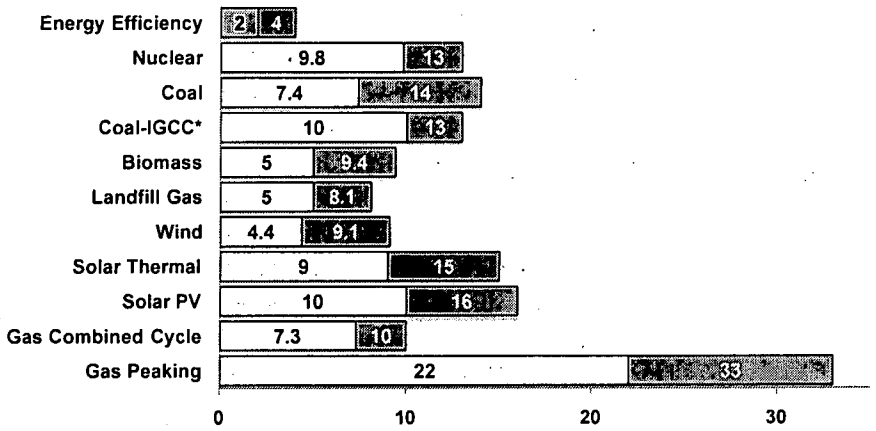


Illustrations courtesy of Recycled Energy Development, LLC

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$EE << $Generation

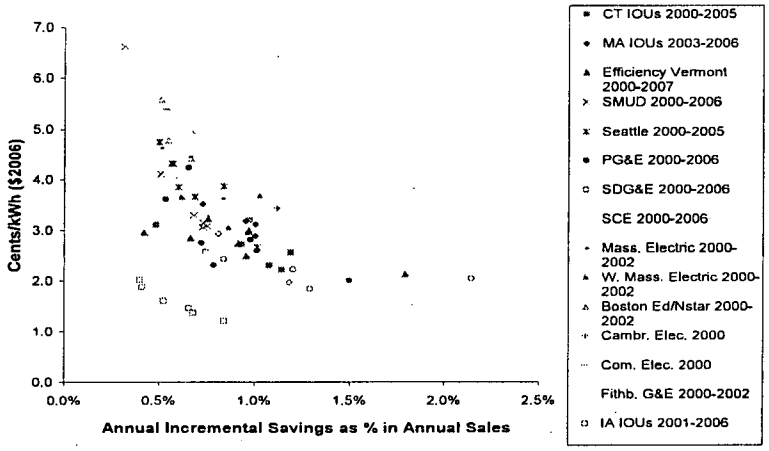


Source: Lazard 2008

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Larger Savings → Lower Cost

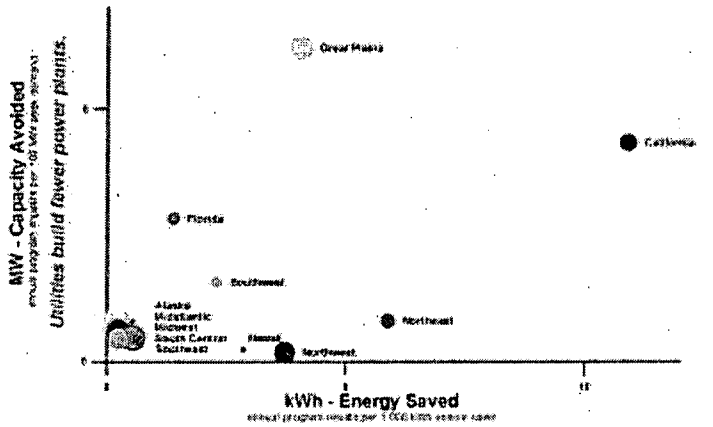


Source: Synapse Energy Economics

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Florida Emphasizes Capacity Savings over Energy Savings



Customers buy less electricity, cause less global warming pollution.

Source: SACE analysis of Energy Information Administration data (2005-06)

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Achieving Energy Efficiency



- **Homes, businesses and factories @ 2 - 4 ¢ / kWh**
  - Building codes, appliance/equipment standards
  - Energy Efficiency Resource Standard (RPS / EPS / REPS)
  - Rate structure reform (decoupling)
  - New utility programs



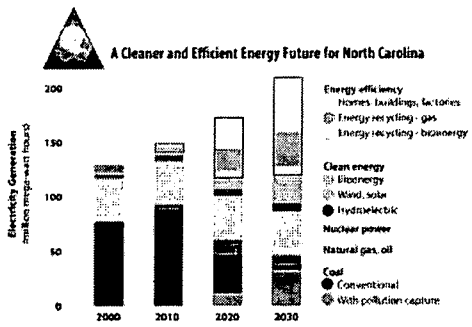
- **Energy recycling (CHP)**
  - Rate structure reform (decoupling, interconnection)
  - State outreach



- **Fuel economy**
  - Plug-in hybrid electric vehicle technology development
  - California vehicle emissions standards
  - Federal fuel economy standards

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Energy Efficiency Helps Out

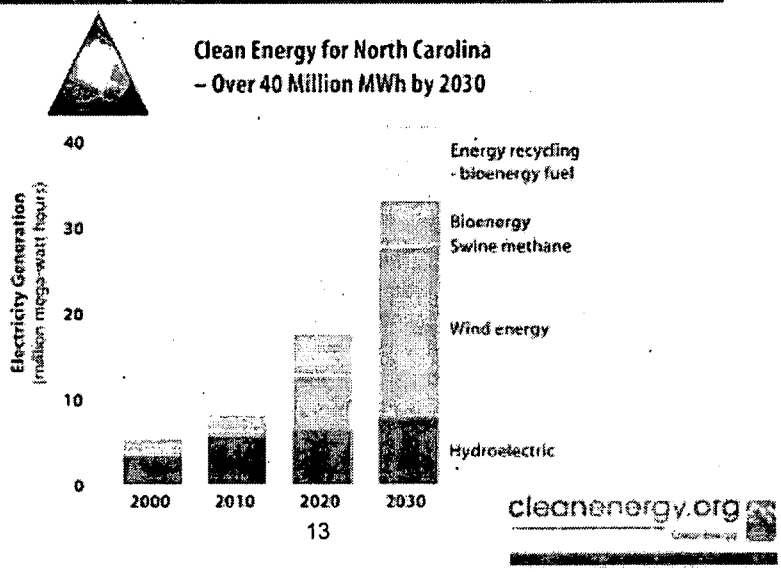


- **Less electricity demand →**
  - easier to reach renewable goals
  - lower cost generation solutions
  - saves critical resources (water)
- **Energy recycling (CHP / waste heat recovery) →**
  - lower grid infrastructure costs
  - Solar, etc. a better "fit"
- **Less fuel demand →**
  - easier to reach biofuels goals
  - less air pollution

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Clean Energy: Electricity

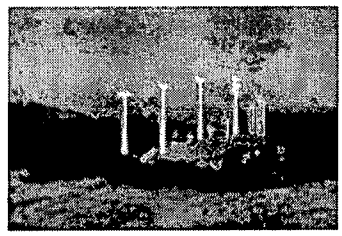


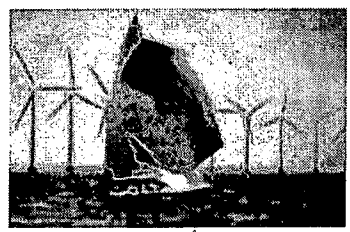
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Clean Energy: Wind

- **Ridge tops in WNC:**
  - Most cost-effective
  - 11 million MWh potential at low impact sites
- **Offshore wind:**
  - Enormous potential
  - Less cost than nuclear power
  - Unclear permitting process
- **20 million MWh by 2030:**
  - <10% of feasible generation
  - < 5% of theoretical potential





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Low-impact Hydroelectric

- **Today: 5 million MWh**
- **2030: 7 million MWh**
- **Resources:**
  - Upgrades of existing dams
  - Small "low-head" (no dam) projects
  - Many projects best suited for third parties, not utilities

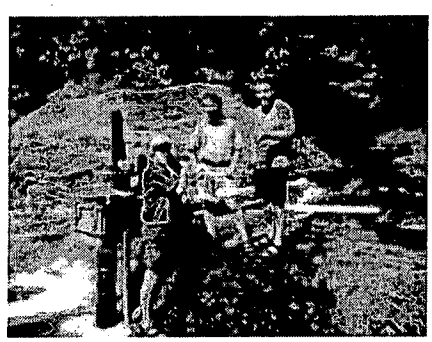


Photo courtesy of Energy Systems and Design

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Clean Energy: Biopower

- **Today: 2 million MWh**
- **2030: 14 million MWh**
- **Resources:**
  - Agricultural and wood wastes
  - Energy crops grown on disused land



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Clean Energy: Solar

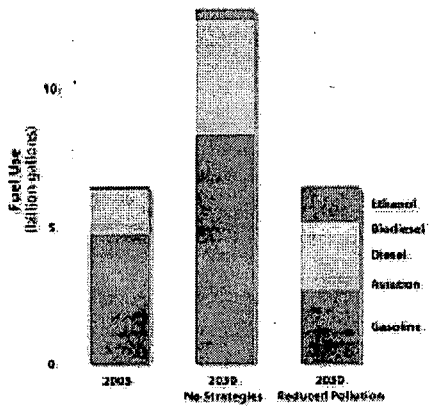


- **Solar hot water**
  - Cost-effective
  - Rapid growth
- **REPS carve-out driving PV**
  - Small-scale (homes)
  - Pilot utility projects
- **Customers face problems**
  - Net metering gets an "F"
  - REPS-driven projects should deliver solutions

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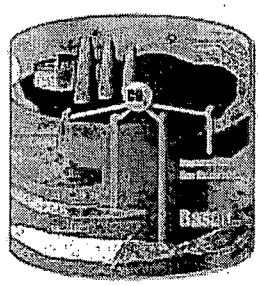
Clean Energy: Fuels

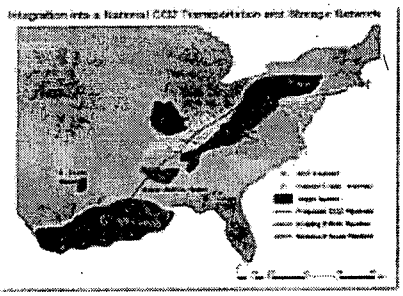


- **Regionally-produced biofuels**
- **Can supply 25-30% of demand**
  - Depends on meeting efficiency targets
- **Pollution reduction achieved with:**
  - Biodiesel (waste oil, oilseeds)
  - Cellulosic ethanol

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Pollution Capture: Geologic



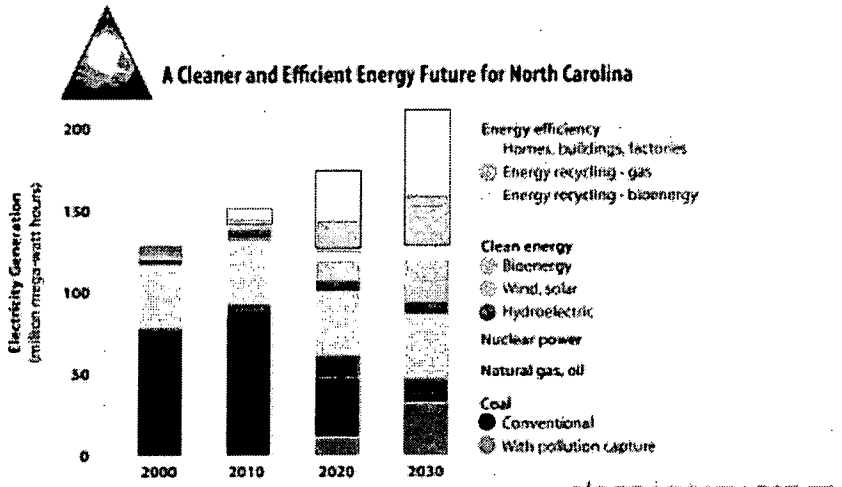


- **Capture-capable coal plants send CO2 to TN or offshore**
- **Pipeline cost less than 15% total project cost**
- **With efficiency and clean energy, cost could be $800 million**
- **This is less than 1 cent per kWh generated electricity**

Illustrations courtesy of Pacific Northwest National Laboratory and Nicholas Institute for Environmental Policy Solutions, Duke University

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Foundation for a Clean Energy Future



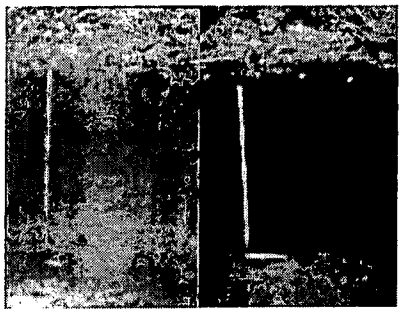
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Pollution Capture: Landscape



Improved Management Practices



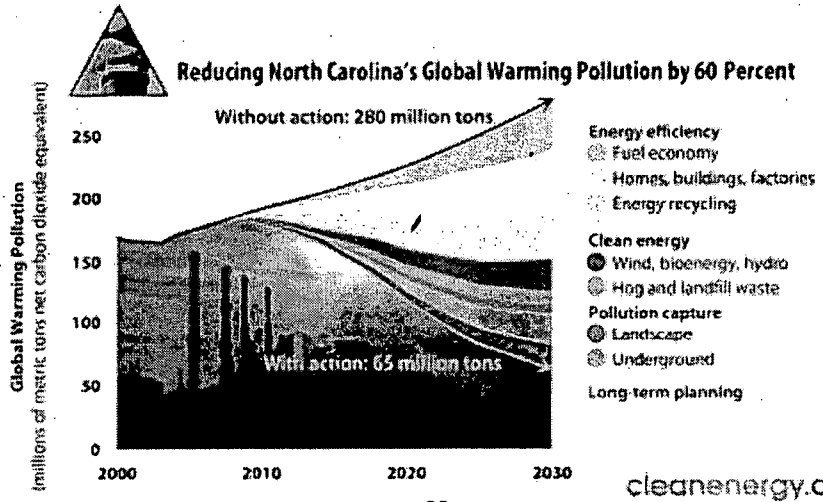
Biochar R&D

Photos courtesy of Alabama NRCS and University of Bayreuth

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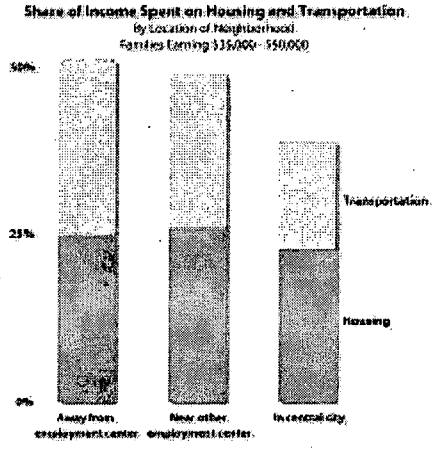
Long-term Planning



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Planning for Family Budgets

- **Housing + transportation costs are lower in central cities**



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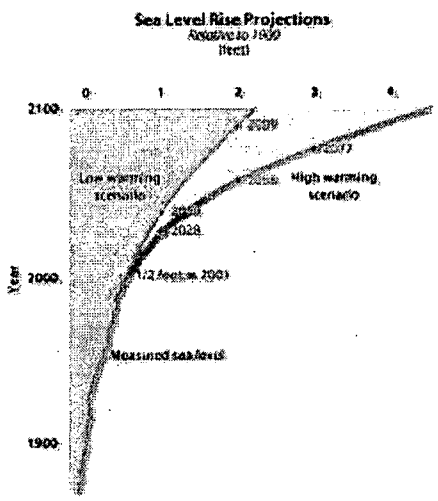
Long-Range Planning for a Changed North Carolina



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Sea Level Rise



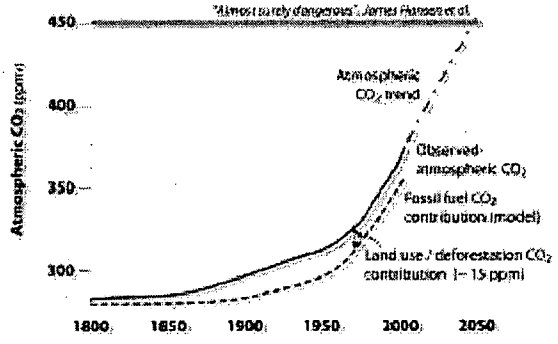
Source: Rahmstorf, *Science* (2007).

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Where does 60% lead?

- **Stabilize emissions to reach 450 ppm by 2050?**
  - No ☹
  - emissions flatten out from 2030 to 2050
- **Is 450 ppm by 2050 enough?**
  - Maybe not, Hansen talking about needing to stabilize at 350 ppm now
- **But . . . 2 decades gives us time to find better solutions**
  - (fingers crossed)



Source: Kharecha and Hansen, *Global Biogeochemical Cycles* (2007), and Hansen et al., *Atmospheric Chemistry and Physics* (2007).

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Cornerstones

Pollution Reduction Strategies	Projections for 2030
	reductions in millions of tons
Energy efficiency	**126.6**
Homes, buildings and factories	52.9
Energy recycling	33.1
Fuel economy	40.6
Clean energy	**37.2**
Wind, bioenergy and hydroelectric	25.6
Methane to energy (hog and landfill waste)	11.6
Pollution capture	**31.1**
Carbon enrichment of landscape	5.5
Underground storage of global warming pollution	25.5
Long-range planning	**19.0**
Total for 60% reduction	**213.9**

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Action Today

Pollution reduction areas	Our 2020 targets	Initial actions
Energy efficiency - electricity demand reduction	❖ 18% residential ❖ 18% commercial ❖ 14% industrial	❖ NC law – 5% energy efficiency by 2021 ❖ New utility proposals ❖ Utility commission review
Energy efficiency - natural gas, other fuels demand reduction	❖ 18% residential ❖ 18% commercial ❖ 14% industrial	❖ No pending NC action
Energy efficiency - fuel economy	❖ 16% reduction in fuel per mile (increase from 25 to 39 mpg by 2030)	❖ No pending NC action ❖ 2007 Energy Bill raises fuel economy standards
Energy efficiency - energy recycling	❖ 15% of energy supply	❖ No pending NC action
Clean energy - electricity	❖ 16% of electricity supply ❖ Ridge and coastal law for wind projects	❖ NC law – 7.5% renewable by 2021 ❖ US Congress considering renewable energy standard
Clean energy - biofuels	❖ 18% of fuel supply ❖ 71% hog methane capture and use for electric generation	❖ NC law – support for biofuels center ❖ Hog methane systems eligible for grants, higher electricity purchase price
Pollution capture - underground storage	❖ State permitting requirement for new plants to capture and store pollution	❖ No pending NC action

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Legislative Action

- **Energy Efficiency**
  - Appliance standards / building energy codes (adopted, need action)
  - State efficiency standard (go beyond REPS)
  - Natural gas efficiency program
  - Energy recycling program (study & net metering recommendations adopted, need action)
- **Clean Energy**
  - Law and programs to foster inland and offshore wind
- **Pollution Capture**
  - State permitting requirement (CO_2 emission limit)
- **Research and Policy Questions**
  - State funding and policy leadership

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The North Carolina Journal of International Law and Commercial Regulation and The University of North Carolina School of Law present:

The Greenhouse Gas Marketplace: Commercial Regulation of Climate Change Solutions

8:30-9:00 Registration/Breakfast -Law School Rotunda

9:00-9:15 Introduction of Dean Boger – Angela Liu – Editor in Chief: North Carolina Journal of International Law and Commercial Regulation

Welcome Address - Jack Boger - Dean of the Law School

9:15-11:15 Panel I – Carbon Trading and Renewable Energy Regulation –Room 5052

- Dr. Brian Murray, Director for Economic Analysis, Nicholas Institute for Environmental Policy Solutions, Research Professor Nicholas School of the Environment and Earth Sciences, Duke University;
  "Climate Change Policy and Carbon Markets: Where are we now? Where are we headed?"

- Ms. Tauna M. Szymanski, Associate, Hunton & Williams, Resources, Regulatory & Environmental Law, focusing on climate change law, including emission reduction and renewable energy projects, policy analysis, regulatory advice and carbon trading globally;
  "Issues in International and Domestic Carbon Trading and Regulation in Day to Day practice."

- Professor Maria Savasta-Kennedy, Clinical Professor of Law and Director of the Externship Program, University of North Carolina School of Law
  "The Newest Hybrid; Lessons from Organics as a Model for Standardizing Carbon Offset Certification"

- Ms. Lori Bird, Senior Energy Analyst with the National Renewable Energy Laboratory in Golden, Colorado, specializing in the area of renewable energy markets and policy;
  "Voluntary Renewable Energy Markets in the Context of Carbon Regulation"

Question & Answer

Moderated by Professor Saule Omarova, Assistant Professor of Law, University of North Carolina School of Law

11:20-12:00 Presentation- *"Corporate Assessment of Climate Change Risks: Shifts in SEC Filings 1995-2008"* – Room 5052

- Professor Kevin Doran, Associate Director & Senior Fellow, Center for Energy and Environmental Security, University of Colorado School of Law; and Elias L. Quinn Research Analyst, Center for Energy and Environmental Security, University of Colorado Law School

12:00-12:15 Lunch gathering in Rotunda

12:15-12:45 Lunchtime Keynote Address – Introduction by Daniel Conrad – Symposium Editor, North Carolina Journal of International Law and Commercial Regulation

- Dr. Michael Wara, Assistant Professor of Law at Stanford Law School and Research Fellow at the Program in Energy and Sustainable Development in Stanford's Freeman Spogli Institute for International Studies;
  "Proposals for Reform of the Clean Development Mechanism in the post-2012 Climate Policy Architecture"

12:45-1:00 Question & Answer – Return to Room 5052 for Panel II

1:00-3:00 Panel II – Domestic and International Government and Industry Reaction

- Dr. William Burns, Senior Fellow, Center for Global Law and Policy, Santa Clara University School of Law, Adjunct Professor, Stanford University Department of Earth Systems;
  "Insurance Systems to Facilitate Adaptation in Highly Vulnerable Developing Countries Facing Climate Change"

- Professor Sean B. Hecht, Executive Director of the UCLA Environmental Law Center at UCLA School of Law, Co-director of the Frank G. Wells Environmental Law Clinic and in addition directs the activities of the Evan Frankel Law and Policy Program;
  "Greenhouse Gas Mitigation and Collective Action in the Insurance and Banking Industries"

- Mr. Robert B. McKinstry Jr., Partner, Ballard Spahr Andrews & Ingersoll, LLP, Founding Partner of the firm's Environmental Law Practice Group, Vice President and General Counsel of Carbon Trap Technologies, Adjunct Professor and Former Maurice K. Goddard Chair in Forestry and Environmental Resources Conservation in the Penn State School of Forest Resources;
  "Integration of state and regional programs into a national program under the Clean Air Act"

- Professor Cymie Payne, Director of the Global Commons Project and Associate Director of the California Center for Environmental Law and Policy at University of California, Berkeley, School of Law, where she is also a Lecturer in Residence teaching Climate Change Law & Policy, International Environmental Law, and International Tribunals and the Environment.
  "The Intersection of International Trade Law, Specifically the World Trade Organization, with State Climate Regulation and Biofuels Policy"

Question & Answer

Moderated by Professor Donald Hornstein, Aubrey L. Brooks Professor of Law, University of North Carolina School of Law

3:00-3:05 Closing Remarks

North Carolina



Climate Action Plan Advisory Group (CAPAG)

Recommended Mitigation Options for Controlling Greenhouse Gas Emissions



Final Report
October 2008

North Carolina



Climate Action Plan Advisory Group (CAPAG)

Recommended Mitigation Options for Controlling Greenhouse Gas Emissions



Executive Summary

October 2008

Secondary Economic Impact Analysis Of Greenhouse Gas Mitigation Options For North Carolina

Prepared For The Center For Climate Strategies

Appalachian State University Energy Center
October 2008

David Ponder
Jeffery Tiller
Jason Hoyle

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EXECUTIVE SUMMARY

In July 2007, the Center for Climate Strategies (CCS) approached the Appalachian State University (ASU) Energy Center to conduct a secondary analysis of the potential economic and jobs impacts of various greenhouse gas (GHG) emissions reduction strategies developed by the North Carolina Climate Action Plan Advisory Group (CAPAG). The ASU Energy Center examined thirty of the fifty-six mitigation options developed by the CAPAG. The thirty options were bundled into twenty-two mitigation option scenarios with similar policies grouped together for analysis. Combined these options account for more than 90% of the greenhouse gas emissions reductions and offsets identified by the CAPAG.

For the study, the ASU Energy Center utilized the N.C. Energy Scenario Economic Impact Model (NCESEIM). Originally developed in 2005 for the North Carolina Energy Policy Council, the model assesses the impacts of various energy policies on the North Carolina economy, measured in terms of employment, employee and proprietor compensation (income), and the incomes earned by labor and capital (total value-added or gross state product).

At the core of the NCESEIM is an input-output economic impact model that estimates how a given change in public policy might result in positive or negative impacts to the economy. Input-output analysis conceives of the economy as a set of interrelated sectors where the consumption of finished goods and services, or final demand, catalyzes a chain reaction of production. As final demand for goods and services change, the upstream sectors in the economy respond accordingly, creating a ripple or multiplier effect. The economic multipliers in the NCESEIM are derived from data published by the Minnesota IMPLAN Group.

While more sophisticated econometric models exist, input-output analysis is typically a reasonable approximation of the economic impacts associated with the type of modest policy changes considered by the CAPAG. Moreover, numerous national, regional, and state level studies utilize a similar approach in estimating the potential economic impacts of changes in energy policy (Laitner 2006).

Based on the technical assumptions of the CAPAG, the ASU Energy Center estimated the implications for energy consumption and public and private investments in the state's economy for each policy bundle†. A given policy can result in both positive and negative economic effects on the demand for goods and services in the economy and certain economic sectors with the particular effect varying by characteristics of the policy. Both positive and negative effects of a policy were considered when modeling its economic impacts and the reported results reflect the net effects across the economy.

As shown in the following table (Table ES-1), by 2020, the mitigation options analyzed would result in the creation of more than 15,000 jobs, $565 million in employee and proprietor income, and $302 million in gross state product. For the study period, 2007–2020, the mitigation options analyzed would generate more than $2.2 billion net present value (NPV) in net additional employee and proprietor

† In some cases, the Technical working groups could not directly provide the policy inputs in the format specified in the model and it was necessary to supplement the CAPAG analysis. In these instances, the study relied on literature modeling the impacts of similar initiatives to estimate the policy impacts.

income and more than $1.2 million (NPV) in net gross state product.* The base year for the NC ESEIM is 2004; therefore all results are reported in 2004 dollars.

Table ES-1: Summary Results for All Options

	Net Annual Employment (FTE)			Net Income ($2004, million)				Total Value-Added ($2004, million)			
	2010	2015	2020	2010	2015	2020	2007-2020 NPV	2010	2015	2020	2007-2020 NPV
Energy Supply Options	(409)	(384)	1,744	(41)	(53)	26	(297)	(99)	(152)	(118)	(1,046)
Residential, Commercial, and Industrial Options	3,518	6,961	9,110	136	271	364	1,942	114	125	42	937
Agriculture, Forestry, & Waste Management Options	1,202	1,960	3,318	39	75	183	649	78	145	331	1,267
Transportation and Land Use Options	783	432	871	(1)	(19)	(8)	(91)	24	7	48	128
All Options	**5,094**	**8,970**	**15,042**	**134**	**274**	**565**	**2,203**	**116**	**126**	**302**	**1,287**

Note: Values in parentheses identify loss of jobs, income, or Value-Added to the economy. FTE = full-time equivalent; NPV = net present value

* Net present value (NPV) is calculated assuming a discount rate of 5%.

Chapter 1 Analysis Overview

North Carolina Climate Action Plan

In 2002, North Carolina enacted the Clean Smokestacks Act which directed the state Department of Environment and Natural Resources (DENR) Division of Air Quality (DAQ) to examine potential options for reducing emissions of carbon dioxide (CO_2), a greenhouse gas that contributes to global warming, from coal-fired power plants and other stationary sources. The bill directed the DAQ to present its findings to the Environmental Management Commission (EMC), the state's environmental rulemaking authority, and the Environmental Review Commission (ERC), the legislative environmental oversight committee. In 2005, the DAQ presented a final report to these bodies describing a series of broad policy recommendations aimed primarily at encouraging voluntary measures to track and reduce greenhouse gas emissions, including CO_2. The report also called for the further study of greenhouse gas emissions reduction strategies through a formalized stakeholder process and the development of a North Carolina Climate Action Plan (N.C. Department of Environment and Natural Resources 2005).

The recommendation to craft a state-level climate action plan follows precedent set by a number of other states to inventory prospective policy options and prioritize recommendations based on their potential to reduce greenhouse gas emissions and cost effectiveness. To date, thirty-six states have initiated or completed state level climate action plans (Pew Center on Global Climate Change 2007).

Pursuant to the recommendations in the DAQ report, DENR Secretary Bill Ross convened the forty-three member North Carolina Climate Action Advisory Group (CAPAG) in February 2006. The CAPAG membership consisted of stakeholders from a wide range of interests including electric and natural gas utilities, government agencies, environmental groups, manufacturing industries, and agricultural, forestry, transportation, and tourism interests. The panel was charged with developing consensus recommendations on strategies to reduce greenhouse gas emissions with an emphasis on identifying those strategies with potential economic benefits. The CAPAG process was facilitated by the non-profit Center for Climate Strategies (CCS).

The work of developing specific recommendations was divided among five technical working groups: Energy Supply (ES), Residential, Commercial, and Industrial (RCI), Transportation and Land Use (TLU), Agriculture, Forestry, and Waste Management (AFW); and Cross-Cutting (CC) issues. Each technical working group developed a set of mitigation options designed to reduce or offset the emissions of greenhouse gases in its respective sector. For each mitigation option, the technical working groups assessed the potential greenhouse gas emissions reductions and estimated its costs and benefits over the time period 2007 to 2020.

Through this process, the CAPAG developed fifty-six mitigation options, which combined would cut North Carolina's projected greenhouse gas emissions nearly in half by 2020, from a baseline of 256 million metric tons of carbon dioxide equivalent ($MMTCO_2e$) to 137 $MMTCO_2e$. This reduction would bring North Carolina to within 1% of its 1990 GHG emissions levels by 2020. Moreover the panel's economic analysis suggests implementation of the recommendations would result in a net cost savings (N.C. Climate Action Plan Advisory Group 2007).

The economic analysis conducted by the technical working groups was limited to the direct effects of implementing an option. For each mitigation option, the technical working groups sought to identify the direct costs borne by those entities ultimately responsible for its implementation, whether that entity is a government entity, an individual or private firm, such as an increase in energy prices. Additionally, each technical working group sought to quantify the associated direct benefits with each policy, such as the value of reduced energy consumption. The quantified benefits were subtracted from the quantified costs to produce a net cost. Of the CAPAG's fifty-six recommendations, the technical working groups quantified direct costs and benefits for thirty-five measures of which sixteen yielded cost savings. In the aggregate the thirty-five quantified measures produced net cost savings of $5.1 billion (NPV), over the period 2007-2020 (N.C. Climate Action Plan Advisory Group 2007).

Prioritization of Policies for Analysis

In July 2007, the Center for Climate Strategies (CCS) approached the Appalachian State University (ASU) Energy Center to conduct an analysis of the potential economic and jobs impacts of various greenhouse gas emissions reduction strategies developed by the CAPAG, including the potential impact on employment, personal income and gross state product. Resource limitations prevented analysis of all options so, in consultation with DAQ, the ASU Energy Center prioritized thirty options for analysis. Combined these options account for more than 90% of the GHG emissions reductions and offsets identified by the CAPAG. The thirty options were bundled into twenty-two mitigation option scenarios with similar policies grouped together for analysis (Table 1-1)

Table 1-1: Summary of Bundled CAPAG Mitigation Options

Energy Supply Options
ES-1, ES-2 & AFW-5: Renewable Energy Production Subsidy, Renewable Portfolio Standard, & Biomass Production Subsidy
ES-3 & ES-9: Combined Heat and Power
ES- 6a & 6b: Advanced Coal Technologies
ES- 8: Municipal Biogas
Residential, Commercial, & Industrial Options
RCI-1, RCI-2 & RCI-11: Energy Efficiency Funding & Energy Audits
RCI-4 & RCI-5: Market Transformation & Appliance Standards
RCI-6: Energy Codes
RCI-7 & RCI-3: High Performance Buildings
RCI-9: Bulk Purchasing for Energy Efficient Appliances
RCI-10: Solar Water Heating Only
Agriculture, Forestry, & Waste Management Options
AFW-1: Manure Digesters
AFW-2: Biodiesel Production Subsidy
AFW-4a & AFW-4b: Conservation Easements
AFW-6: Cellulosic Ethanol Production Subsidy
AFW-8: Afforestation
AFW-9 & AFW-10: Forest Management
AFW-11: Landfill Gas
AFW-12: Recycling
AFW-13: Urban Forestry
Transportation & Land Use Options
TLU-1b: Multi-modal Transportation and Promotion
TLU-3a: Vehicle Registration Surcharge to Fund Multi-modal Transportation
TLU-5: Tailpipe Greenhouse Gas Emissions Standards

N.C. Energy Scenario Economic Impact Model

For the study, the ASU Energy Center utilized the N.C. Energy Scenario Economic Impact Model (NCESEIM). Originally developed in 2005 for the North Carolina Energy Policy Council, the model assesses the impacts of various energy policies on the North Carolina economy, measured in terms of employment, employee and proprietor compensation (income), and the incomes earned by labor and capital (total value-added or gross state product).

The NCESEIM was originally developed by Jeffery Tiller, PE, Professor of Technology and Technical Director at the ASU Energy Center; John "Skip" Laitner, Senior Economist at the American Council for an Energy Efficient Economy; Doug Arent, Director of the Strategic Energy Analysis and Applications Center at the U.S. Department of Energy's National Renewable Energy Laboratory; and Chris Larsen, formerly of the ABB Group. Additionally, the model was peer reviewed by Adam Rose, Ph.D., Economist and Acting Director of the Energy Institute at the University of Southern California (Rose and Wei 2005). The platform for the model is a series of interconnected Microsoft Excel spreadsheets. The model consists of two main components, an input-output economic impact model and a modifiable policy design module. Each component itself consists of a subset of Excel spreadsheets.

Input-Output Economic Impact Model

At the core of the NCESEIM is an input-output economic impact model that estimates how a given change in public policy might result in positive or negative impacts to the economy, measured in terms of employment, personal income, and gross state product. These impacts are calculated using economic multipliers derived from state-level data for North Carolina published by the Minnesota IMPLAN Group, publishers of IMPLAN Professional, a computer software application for conducting input-output economic analysis. IMPLAN in turn relies on data from a number of federal and state agency sources, including the U.S. Department of Commerce, Bureau of Economic Analysis *Benchmark Input-Output Accounts*.

Input-output analysis was conceptualized by Nobel laureate Wassily Leontief to describe the economic linkages among various sectors of the U.S. economy and predict the consequences of positive and negative economic stimuli. The approach conceives of the economy as a set of interrelated sectors where the consumption of finished goods and services, or final demand, catalyzes a chain reaction of production (Leontief 1986).

According to the theory, in order to meet the final demand for goods and services, a supplying sector depends on inputs (e.g., raw materials, services, unfinished goods, capital equipment, etc.) from other sectors of the economy. In turn, those other sectors depend on goods and services from other sectors in the economy. The output of each sector is an input for another sector. As final demand for goods and services changes, the upstream sectors in the economy respond accordingly, creating a ripple or multiplier effect (Hy 1999).

Input-output models measure the multiplier effect. These impacts are expressed in terms of their direct, indirect, and induced effects on sectoral output, employment, income, and gross state product.

Direct effects are the initial effects associated with the change in the final demand for a particular sector. The indirect effects are the inter-industry impacts resulting from production changes in backward-linked industries caused when input needs change due to the impact of directly affected industry. The induced effects represent the response by local industries caused by increased expenditures of new household income. Input-output analysis quantifies the impact of these effects through the derivation of coefficients called multipliers that indicate the overall change in activity that results from an initial change in final demand. So-called Type II multipliers capture the direct, indirect, and induced effects (Schaffer 1999).

Consider for example the construction of a new school. The local school board will solicit and award a bid for a construction firm to build the new school, the direct effects. In turn, the construction firm must secure insurance, hire engineers & subcontractors, purchase construction materials and so on, the indirect effects. The increase in demand for these construction sector inputs leads to increases in household income as the supplying sectors hire and compensate employees to meet the increased demand. The expenditure of this household income in turn spurs further increases in final demand, the induced effect.

Input-output analysis, like all econometric models, makes some important simplifying assumptions to develop a parsimonious model.* First, it assumes discrete enterprises (e.g. a farm growing soybeans) can be grouped into common economic sectors (e.g. oil seed and grain farming) based on the type of commodities produced or services rendered (ten Raa 2006). The NCESEIM utilizes a thirty-nine sector model of the state's economy aggregated from the 2004 IMPLAN data for North Carolina.

The approach also assumes the relationship between the inputs and outputs of these aggregated sectors is linear, that is to say that as sector output increases or decreases its inputs increase or decrease proportionally. Moreover input-output analysis assumes the production recipes expressed in the economic multipliers is static. That is to say the technology used to produce a good or service does not change over time. However, some studies suggest that the technologies of core sectors, especially when aggregated to the levels in the NCESEIM, tend to remain fairly stable. The approach also assumes that an industry has unlimited access to capital, raw materials, intermediate goods and services, and labor. Thus, changes in prices for inputs do not result in substituting behavior or curtailment of production (Minnesota IMPLAN Group 2004).

The NCESEIM seeks to overcome some of these limitations by factoring in labor productivity improvements into the employment multipliers using forecasts of average rates of change from the U.S. Department of Labor, Bureau of Labor Statistics (U.S. Department of Labor 2007).

It should also be noted that the NCESEIM does not account for effects on the broader national economy and that the impacts in North Carolina may be offset by reduced activity in other regions from which

* For a more thorough discussion of the relative strengths and weaknesses of input-out models relative to other econometric impact models see West, G. (1995). "Comparison of Input-Output, Input-Output Econometric and Computable General Equilibrium Impact Models at the Regional Level." *Economic Systems Research,* Vol. 7, No. 2, p207-227.

resources are drawn. For example, the NCESEIM does not account for a reduction in coal mining activity in West Virginia resulting from a decrease in coal-fired electricity consumption in North Carolina.

The table below (Table 1-2) summarizes the economic multipliers utilized in the NCESEIM to calculate the impact of changes in final demand resulting from various policy changes quantified in the NCESEIM's modifiable policy design module. These multipliers were derived from state-level data for 2004 compiled by the Minnesota IMPLAN Group. The detailed methodology for this derivation is spelled out in Appendix A.

Table 1-2: Employment, Income, and Gross State Product Multipliers from NCESEIM

SECTOR	Employment (Per $ Million of Final Demand)	Labor Productivity Adjustment[a]	Income (Per Million $ of Final Demand)	GSP (Per Million $ of Final Demand)
Oil Seed & Grain	11.11	2.20%	0.42	0.42
Other Ag	12.89	2.20%	0.56	0.56
Animal Production	12.25	2.20%	0.29	0.29
Forestry	7.63	2.20%	0.30	0.30
Mining	7.10	1.18%	0.31	0.31
Electric Utilities	3.58	1.80%	0.27	0.27
Natural Gas Utilities	3.84	-2.22%	0.21	0.21
Water & Sewer Utilities	9.14	0.54%	0.42	0.42
Residential Construction	13.05	1.08%	0.46	0.46
Commercial Construction	15.88	1.08%	0.57	0.57
Highway Construction	14.64	1.08%	0.55	0.55
Heavy Construction	15.13	1.08%	0.56	0.56
Food, Beverage, Tobacco	6.41	1.00%	0.26	0.26
Starch & Vegetable Fats & Oil Mfg	3.28	3.31%	0.16	0.16
Furniture & Textiles	9.77	2.39%	0.39	0.39
Wood & Paper Products	6.85	0.97%	0.32	0.32
Other Manufacturing	10.02	3.83%	0.52	0.52
Petroleum & Chemicals	4.30	1.66%	0.26	0.26
Nonmetal Materials	7.59	1.21%	0.38	0.38
Metals	6.65	2.42%	0.32	0.32
Machinery	6.14	2.23%	0.35	0.35
Computers & Electronics	4.91	11.92%	0.37	0.37
Electrical Equipment & Appliance	7.07	4.17%	0.39	0.39
Transportation Manufacturing	4.99	2.91%	0.28	0.28
Wholesale Trade	9.23	5.29%	0.47	0.47
Transportation & Warehousing	13.24	2.44%	0.56	0.56
Transit Transportation	23.70	0.70%	0.57	0.57
Retail Trade	19.51	3.36%	0.53	0.53
Information	6.20	3.89%	0.34	0.34
FIRE	8.85	2.55%	0.37	0.37
Other Services	10.25	1.60%	0.29	0.29
Professional, Scientific, Technical, Mngmt	11.42	2.19%	0.61	0.61
Administrative & Support Services	26.94	1.73%	0.62	0.62
Education	25.26	-0.22%	0.88	0.88
Health Care & Social Assistance	17.98	0.92%	0.68	0.68
Arts & Entertainment	25.58	1.42%	0.56	0.56
Accommodation & Food Services	25.67	0.54%	0.47	0.47
Government	14.02	1.42%	0.90	0.90
Waste Management	10.46	0.52%	0.38	0.38
Households	9.71	0.38%	0.32	0.32

[a] Source:(U.S. Department of Labor 2007). Used to adjust employment multipliers for gains/losses in productivity.

ENERGY POLICY DESIGN MODULE

The policy design module specifies the major features of a policy initiative including the implications for energy consumption and public and private investments in the state's economy. For this study, the resulting effects were derived from the assumptions underlying the analysis of the CAPAG technical working groups[†]. These assumptions included fuel, technology, and program costs, as well as energy prices and implementation mechanisms and policy goals.

Based on these assumptions, the module calculates incremental and annual physical energy savings, by each sector and technology, where applicable. The cash value of avoided energy consumption; incremental and annual renewable energy production; annual program implementation expenditures; direct and stimulated private and public investments; and displaced reference case revenue and expenditures are also calculated.

The values derived from this module can have either a positive or negative effect on the demand for goods and services in the economy. For example, when a policy results in a reduction in electricity consumption and a subsequent increase in disposable household income or business cash flows it has a positive impact on sectoral demand. On the other hand, the same policy will also reduce revenue to the electric utility which results in a negative effect to that sector.

The values derived in this module are then allocated across the economy as changes in the demand for goods and services, with the particular allocation varying by the characteristics of the policy. In general, the study sought the most conservative approaches presented in the literature in determining this allocation and is explained more thoroughly in Appendix B of this report. For example, when allocating the impact of investments in renewable energy and biofuel technologies the study only considers the labor portion of the investments. This likely understates the total impact of these investments on the North Carolina economy.

The distribution of the monetary value of avoided electricity and natural gas consumption as well as the impact of utility rate increases is treated similarly for all options. That is, it is assumed that these benefits and costs are distributed to a given economic sector in proportion to that sector's purchase of energy output. The calculation of these coefficients is derived from the 2004 IMPLAN data for North Carolina (Table 1-3). A sector's share of the monetary value of avoided electricity and natural gas consumption is recorded as an increase in final demand for that sector. Conversely, a sector's share of a utility rate increase is recorded as a decrease in final demand for that sector.

† In some cases, the technical working groups could not directly provide the policy inputs in the format specified in the model and it was necessary to supplement the CAPAG analysis. In these instances, the study relied on literature modeling the impacts of similar initiatives to estimate the policy impacts. The detailed methodology for each of the mitigation option considered in this report can be found in Appendix B.

Table 1-3: Energy (Electricity and Natural Gas) Consumption Coefficients

Industrial Customers	Coefficient
Oil Seed & Grain Farming	0.1%
Other Agriculture	0.5%
Animal Production	2.4%
Forestry	0.3%
Mining	0.7%
Electric Utilities	0.0%
Natural Gas Utilities	0.0%
Water & Sewer Utilities	2.9%
Residential Construction	1.7%
Commercial Construction	0.9%
Highway Construction	0.4%
Heavy Construction	0.4%
Food, Beverage, Tobacco Manufacturing	14.8%
Starch & Vegetable Fats & Oil Manufacturing	0.8%
Furniture & Textiles Manufacturing	14.2%
Wood & Paper Products Manufacturing	9.8%
Other Manufacturing	1.0%
Petroleum & Chemicals Manufacturing	20.6%
Nonmetal Materials Manufacturing	9.6%
Metals Manufacturing	8.3%
Machinery Manufacturing	2.3%
Computers & Electronics Manufacturing	3.6%
Electrical Equipment & Appliance Manufacturing	2.0%
Transportation Manufacturing	2.7%
Commercial Customers	
Wholesale Trade	6.2%
Transportation & Warehousing	2.2%
Transit Transportation	0.2%
Retail Trade	15.5%
Information	3.1%
Financial, Insurance, and Real Estate	18.9%
Other Services	6.6%
Professional, Scientific, Technical, Management	8.7%
Administrative & Support Services	2.0%
Education	0.7%
Health Care & Social Assistance	6.5%
Arts & Entertainment	1.7%
Accommodation & Food Services	10.3%
Government	0.0%
Waste Management	17.3%
Residential Customers	
Households	100%

Several of the mitigation options examined include subsidy payments by state government. It was assumed that these payments are paid for from existing revenue and therefore result in a reduction of other state government expenditures. Using 2004 IMPLAN data for North Carolina, the NCESEIM calculates a sector specific Government Spending Coefficient (Table 1-4). In calculating these coefficients the NCESEIM holds constant spending on education. The annual cost of a subsidy is then multiplied by the coefficient and the product recorded as a reduction in final demand.

Table 1-4: Government Spending Coefficients

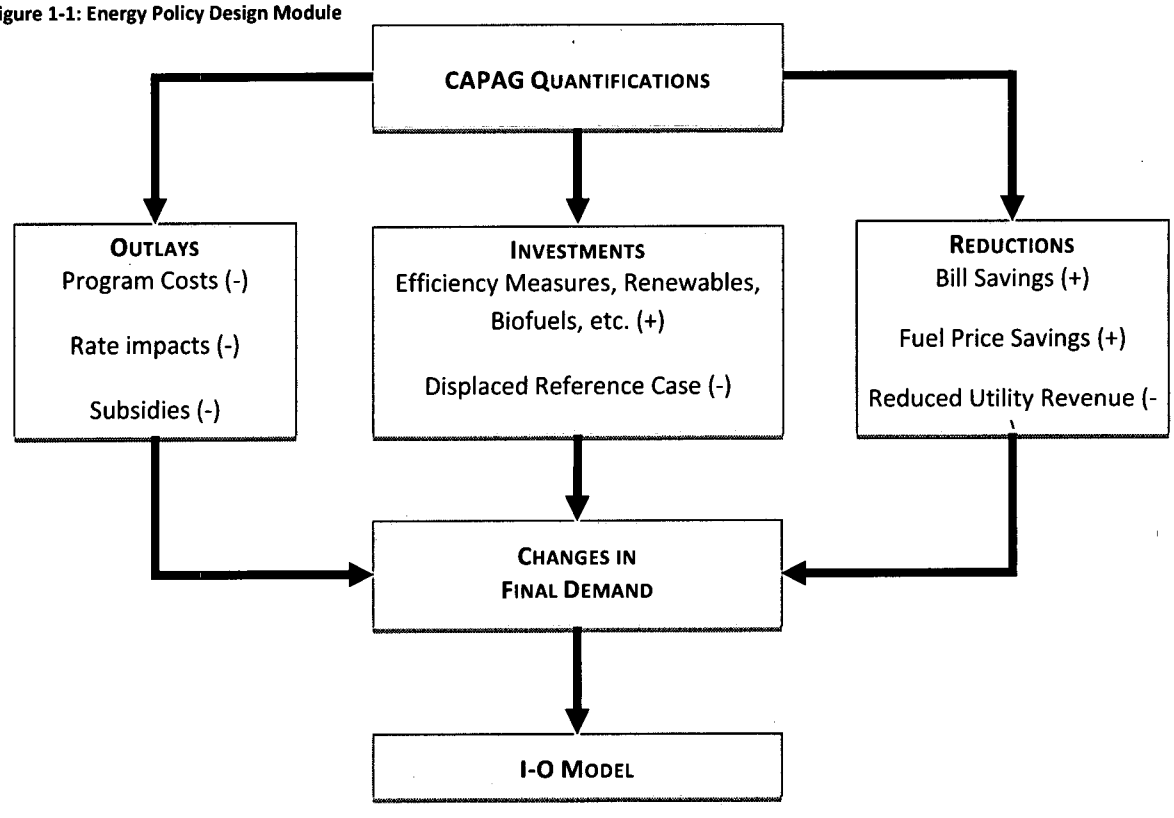
Sector	Coefficient
Oil Seed & Grain Farming	0.00%
Other Agriculture	0.06%
Animal Production	0.03%
Forestry	0.00%
Mining	0.02%
Electric Utilities	2.08%
Natural Gas Utilities	0.40%
Water & Sewer Utilities	0.57%
Residential Construction	0.87%
Commercial Construction	8.42%
Highway Construction	7.28%
Heavy Construction	5.90%
Food, Beverage, Tobacco Manufacturing	1.88%
Starch & Vegetable Fats & Oil Manufacturing	0.00%
Furniture & Textiles Manufacturing	0.55%
Wood & Paper Products Manufacturing	0.05%
Other Manufacturing	0.73%
Petroleum & Chemicals Manufacturing	4.30%
Nonmetal Materials Manufacturing	0.64%
Metals Manufacturing	0.03%
Machinery Manufacturing	0.51%
Computers & Electronics Manufacturing	0.39%
Electrical Equipment & Appliance Manufacturing	0.17%
Transportation Manufacturing	0.34%
Wholesale Trade	2.03%
Transportation & Warehousing	1.46%
Transit Transportation	0.26%
Retail Trade	0.02%
Information	1.50%
Financial, Insurance, and Real Estate	3.52%
Other Services	2.64%
Professional, Scientific, Technical, Mgmt	3.04%
Administrative & Support Services	1.36%
Education	0.00%
Health Care & Social Assistance	0.47%
Arts & Entertainment	0.06%
Accommodation & Food Services	1.48%
Government	25.21%
Waste Management	0.14%
Households	21.58%

The changes in sectoral demand generated by the Energy Policy Design Module, in turn, are utilized by the input-output economic impact model to calculate a given policy's net impact on employment, income, and gross state product*.

The module further assumes that reductions in electricity consumption or additions of new renewable electricity generation displace future additions of conventional electricity generation. While the investments associated with energy efficiency measures and renewable electricity generation result in an increase in final demand, the displaced investment in new conventional electricity generation is reflected as a reduction in final demand. The value of displaced investments is determined by multiplying incremental energy savings or renewable generation by the overnight capital cost per Megawatt-hour (MWh) of the conventional resources†.

Figure 1-1 summarizes the *Energy Policy Design Module,* while a policy-by-policy methodology is found in Appendix B.

Figure 1-1: Energy Policy Design Module



* The allocation of energy savings and operating costs to a change in final demand is an admittedly coarse methodology for estimating the economic impacts associated with what in fact are fundamentally changes in intermediate demand. This is a limitation in current approach that the authors plan on addressing in future versions of the model.

† Displaced investments in conventional generation assumes a fuel mix of 60% pulverized coal and 40% combined cycle natural gas per the CAPAG Energy Supply technical working group reference case (Center for Climate Strategies 2007b). The result is a capital cost of $192.41/MWh and a operating expense of $6.00/MWh (Center for Climate Strategies 2007b). The labor share of capital investments is 26.5% while the labor share of operating expenses is 42% (LaCapra Associates 2006). It was further assumed that the full cost of conventional generation would be financed over a period of 25 year at an interest rate of 8%.

Chapter 2 RESULTS OF ENERGY SUPPLY OPTIONS ANALYSIS

Table 2-1 presents summary results for Energy Supply (ES) options analyzed. By 2020, these options would result in the creation of more than 1,700 jobs, $26 million in employee and proprietor income, but a decrease in $118 million in gross state product. Over the study period, 2007–2020, the options would decrease employee and proprietor income by $297 million (NPV) and net gross state product by $1.046 billion (NPV). The base year for the NCESEIM is 2004; therefore all results are reported in 2004 dollars.

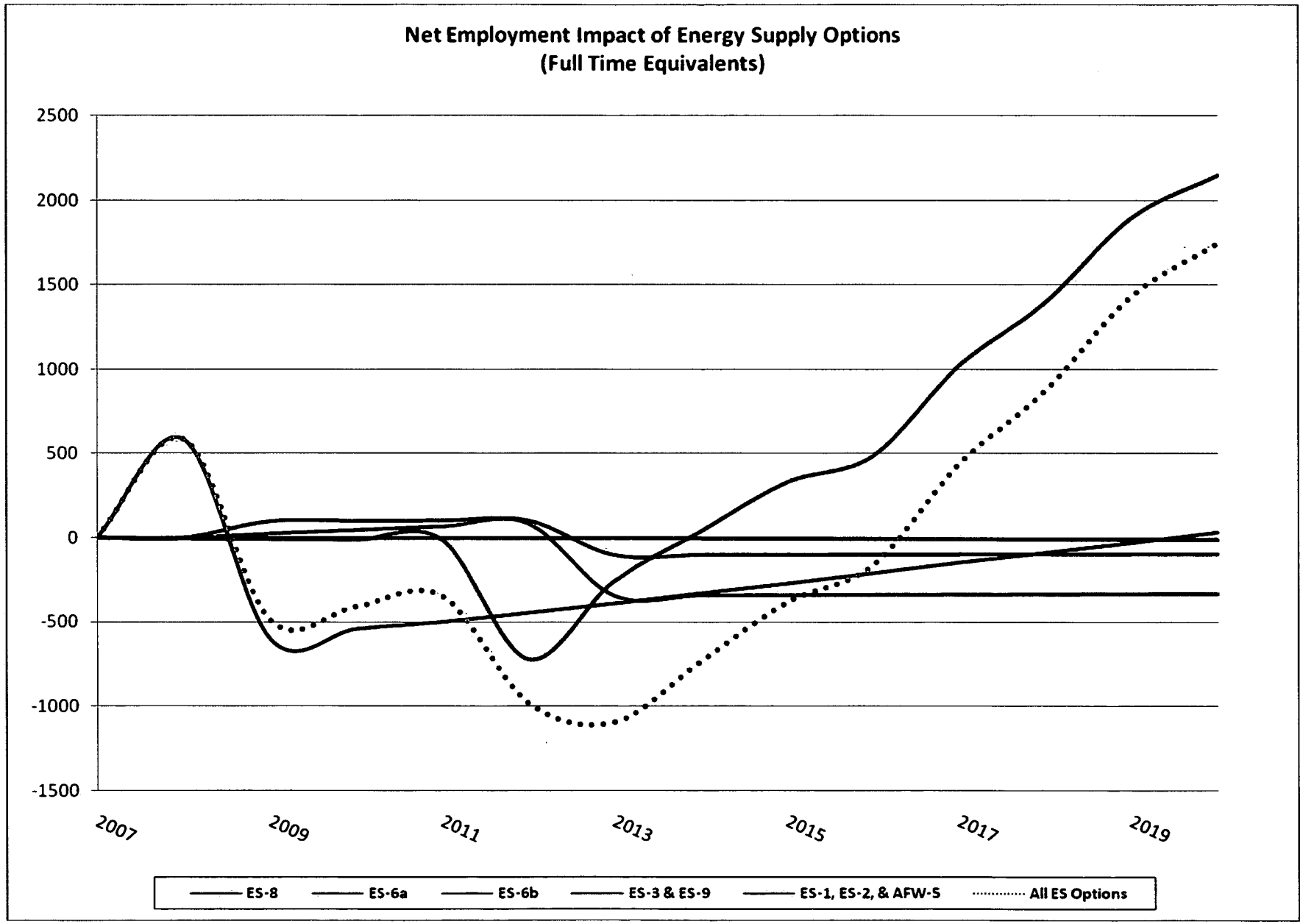
The bulk of these impacts are associated with the construction of combined heat and power (CHP) systems considered in ES 3&9. The negative effects of the CHP option are driven primarily by the technology and fuel price assumptions of the CAPAG, which result in commercial and industrial end-users spending more to install and operate CHP systems than a business as usual case. As a result, firms in these sectors reduce their final demand for endogenous goods and services, the effect of which is amplified throughout the economy, causing the negative effects.

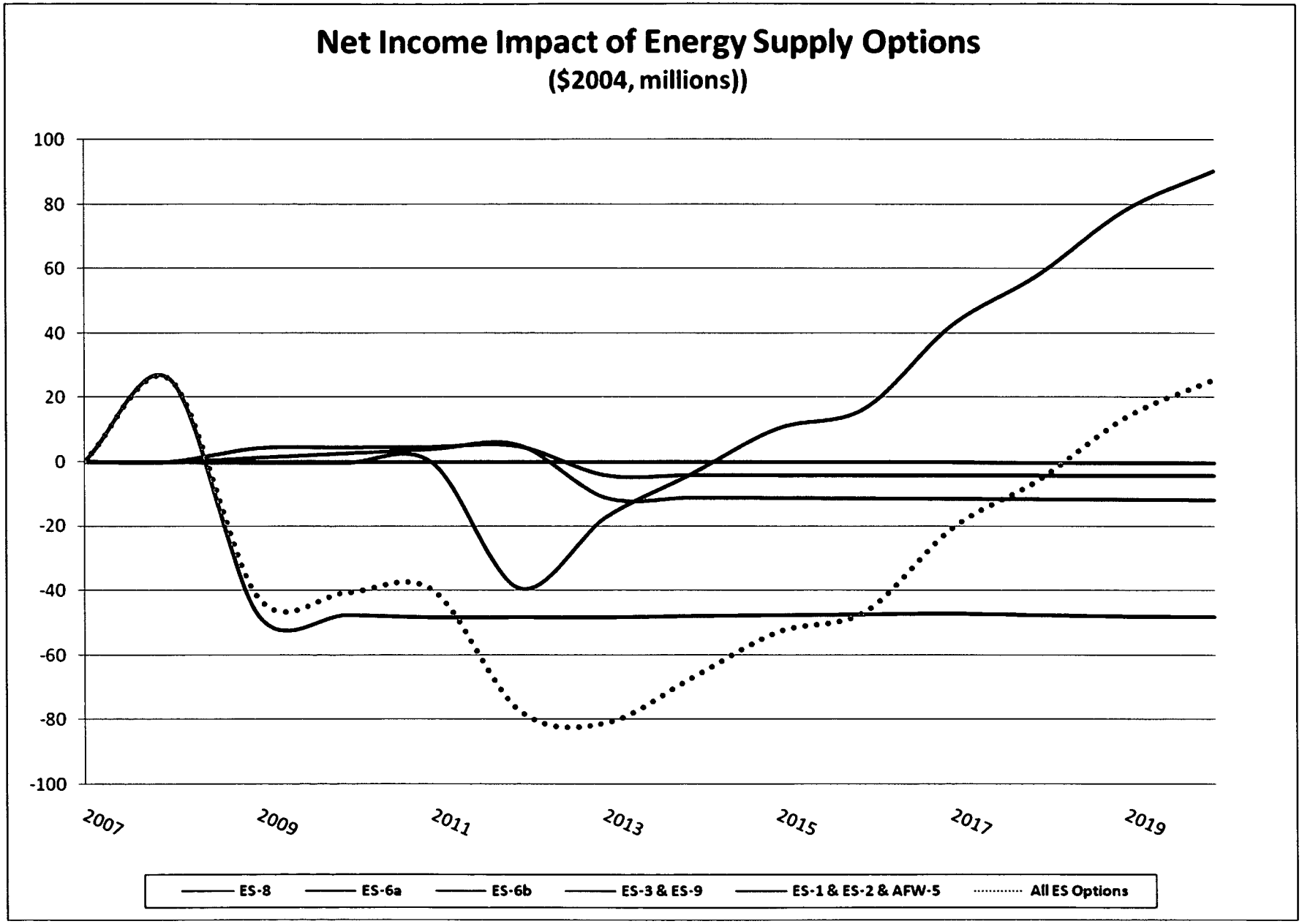
Moreover, in order to remain consistent with the final integration of all option preformed by the CAPAG, the efficiency components of ES-2 are assumed to obtained by the demand side options of the Residential, Commercial, and Industrial technical working group.

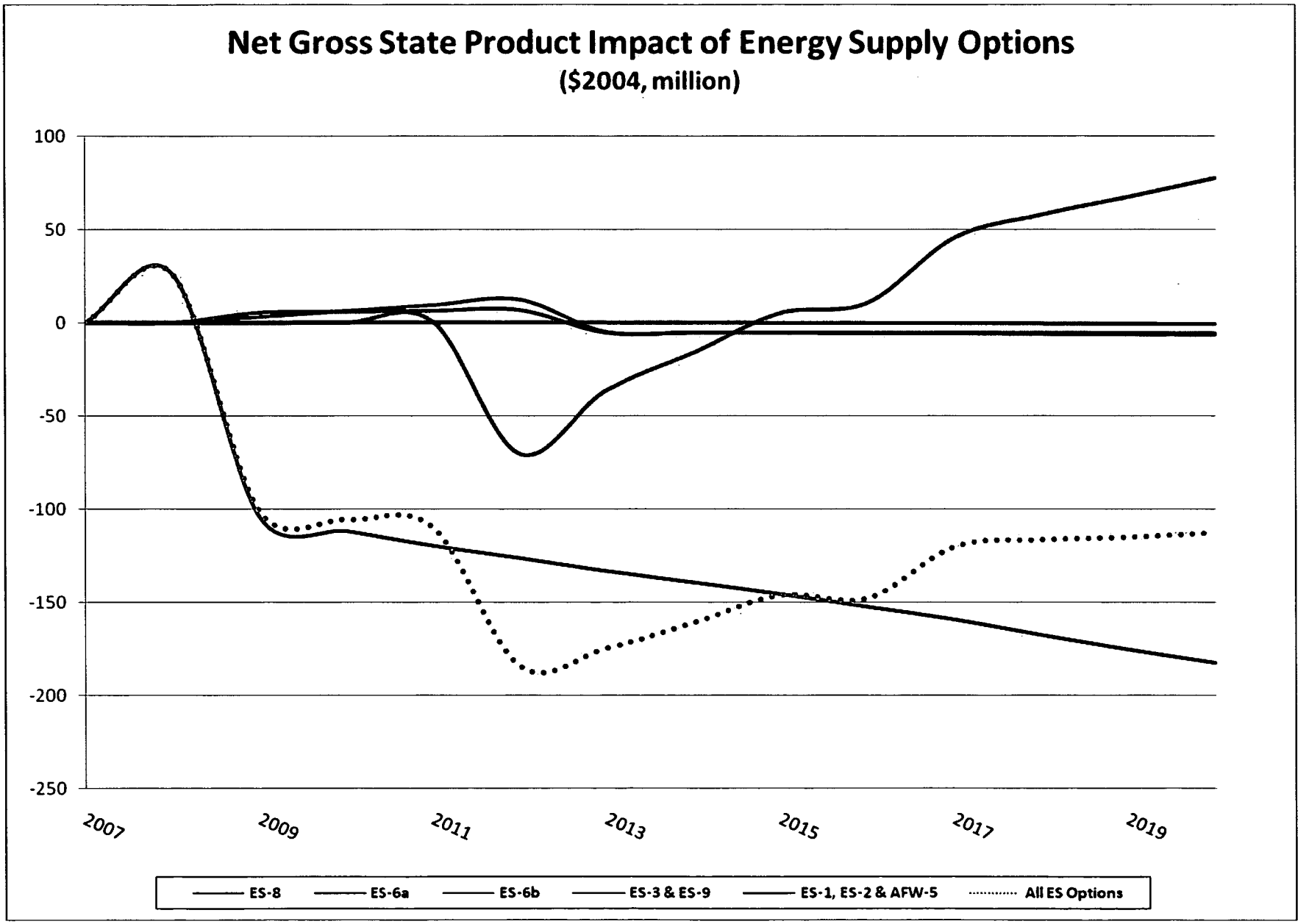
Table 2-1: Summary Results for Energy Supply Options Analyzed

	Net Annual Employment (FTE)			Net Income ($2004, million)				Total Value-Added ($2004, million)			
Energy Supply Options	**2010**	**2015**	**2020**	**2010**	**2015**	**2020**	**2007-2020 NPV**	**2010**	**2015**	**2020**	**2007-2020 NPV**
ES 1 & 2 and AFW 5 (PTC, REPS, Biomass)	(11)	330	2,148	(0)	10	90	116	(0)	5	77	54
ES 3 & 9 (CHP)	(541)	(271)	34	(48)	(48)	(48)	(361)	(112)	(146)	(183)	(1,094)
ES 6a (IGCC)	98	(100)	(96)	4	(4)	(4)	(6)	6	(5)	(6)	(6)
ES 6b (IGCC)	45	(341)	(333)	3	(11)	(12)	(78)	6	(5)	(7)	(3)
ES 8 (Municipal Biogas)	0	(2)	(10)	0	(0.1)	(0.5)	(0.9)	(0)	(0.2)	(0.7)	(1.5)
All ES Policies	**(409)**	**(384)**	**1,744**	**(41)**	**(53)**	**26**	**(297)**	**(99)**	**(152)**	**(118)**	**(1,046)**

Note: Values in parentheses identify loss of jobs, income, or Value-Added to the economy. NPV = net present value. FTE=Full Time Equivalent


Net Employment Impact of Energy Supply Options
(Full Time Equivalents)
2500
2000
1500
1000
500
0
-500
-1000
-1500
2007
2009
2011
2013
2015
2017
2019
ES-8
ES-6a
ES-6b
ES-3 & ES-9
ES-1, ES-2, & AFW-5
All ES Options


Net Income Impact of Energy Supply Options
($2004, millions))
100
80
60
40
20
0
-20
-40
-60
-80
-100
2007
2009
2011
2013
2015
2017
2019
ES-8
ES-6a
ES-6b
ES-3 & ES-9
ES-1 & ES-2 & AFW-5
All ES Options


Net Gross State Product Impact of Energy Supply Options
($2004, million)
100
50
0
-50
-100
-150
-200
-250
2007
2009
2011
2013
2015
2017
2019
ES-8
ES-6a
ES-6b
ES-3 & ES-9
ES-1, ES-2 & AFW-5
All ES Options

ES-1, ES-2 & AFW-5: Renewable Energy Production Subsidy, Renewable Portfolio Standard, & Biomass Production Subsidy

These mitigation options seek to expand the generation of electricity from renewable resources like biomass, wind, and hydroelectric power. ES-1 would provide state incentives to producers of electricity from renewable resources worth $0.005 for each kilowatt-hour of electricity generated. ES-2 considers establishment of a renewable portfolio standard requiring the state's electric utilities to acquire a minimum percentage of the electricity sold to retail customers from renewable energy sources. While the ES technical working group originally considered only three sensitivities for this option, recent legislative action mandated a goal of 12.5% of retail electricity sales be acquired from a combination of renewable resources and energy efficiency measures by 2021. Therefore, the ES technical working group provided a fourth sensitivity reflecting the goals of North Carolina's new Renewable Energy and Energy Efficiency Portfolio Standard (REPS)*. AFW-5 would provide state subsidies to producers of biomass feedstocks from 2007-2011 worth $1.27/MMBtu.

By 2020, these policies would result in the net creation of 2,148 jobs, $90 million dollars in annual employee and proprietor income, and $77 million in annual gross state product. For the study period, 2007-2020, the mitigation options would create an additional $116 million (NPV) in employee and proprietor income and $54 million (NPV) in gross state product.

ES-3 & ES-9: Combined Heat and Power

This mitigation option calls for installation of 1000 MW of new combined heat and power (CHP) systems by 2018. By 2020, this mitigation option would result in the creation of 34 jobs but the loss of $48 million dollars in annual employee and proprietor income and $183 million in annual gross state product. For the study period, 2007-2020, this mitigation option would reduce employee and proprietor income by $361 million (NPV) and gross state product by nearly $1.1 billion (NPV).

The negative effects of the option are driven primarily by the technology and fuel price assumptions of the CAPAG, which result in a "negative payback" where commercial and industrial end-users spend more to install and operate CHP systems than a business as usual case. As a result, firms in these sectors reduce their final demand for endogenous goods and services, the effect of which is amplified throughout the economy, causing the negative effects.

ES-6a & ES- 6b: Advanced Coal Technologies

These mitigation options propose to encourage the construction of an 800 MW integrated gasification combined cycle (IGCC) coal-fired power plant to either replace a future (ES-6a) or an existing (ES-6b) conventional coal-fired power plant. In both instances, the ES technical working group also considered sensitivities for the inclusion of a carbon capture and sequestration (CCS) component. Given the

* The supplemental analysis provided by the ES technical working group did not include the technology specific mandates for renewables articulated in the law but rather continued to assume a distribution based on the 2006 La Capra Associates study of the potential of a renewable portfolio standard for N.C. Utilities Commission. Moreover, the efficiency component of the analysis is supplemental to the estimated efficiency gains in the CAPAG's final integration of ES and RCI options.

unproven potential of CCS, for this study, the ASU Energy Center examined the impacts of the "IGCC only" sensitivity for both ES-6a and ES-6b.

By 2020, ES-6a would result in the net loss of 96 jobs, $4 million in annual employee and proprietor income, and $6 million in annual gross state product. For the study period, 2007-2020, the option would decrease employee and proprietor income by $6 million (NPV) and gross state product by $6 million (NPV). By 2020, ES-6b would result in the net loss of 333 jobs, $12 million in annual employee and proprietor income, and $7 million in annual gross state product. For the study period, 2007-2020, the option would decrease employee and proprietor income by $78 million (NPV) and gross state product by $3 million (NPV).

ES-8: Municipal Biogas

This mitigation option proposes to capture methane emissions from 50% of new municipal sewage treatment facilities built in North Carolina, in order to generate electricity, by 2020. The mitigation option description assumes the cost of implementing the measure will be paid for through state government subsidies to local sewage treatment enterprises.

By 2020 this mitigation option would result in the loss of 10 jobs, $.5 million in annual employee and proprietor income, and $.7 million in annual gross state product. For the study period, 2007-2020, the mitigation option would decrease employee and proprietor income by $.9 million (NPV) and gross state product by $1.5 million (NPV). These study period reductions are a function of government subsidy payments displacing other government expenditures. As those payments are phased out it is likely the effect over a longer horizon would yield a positive impact.

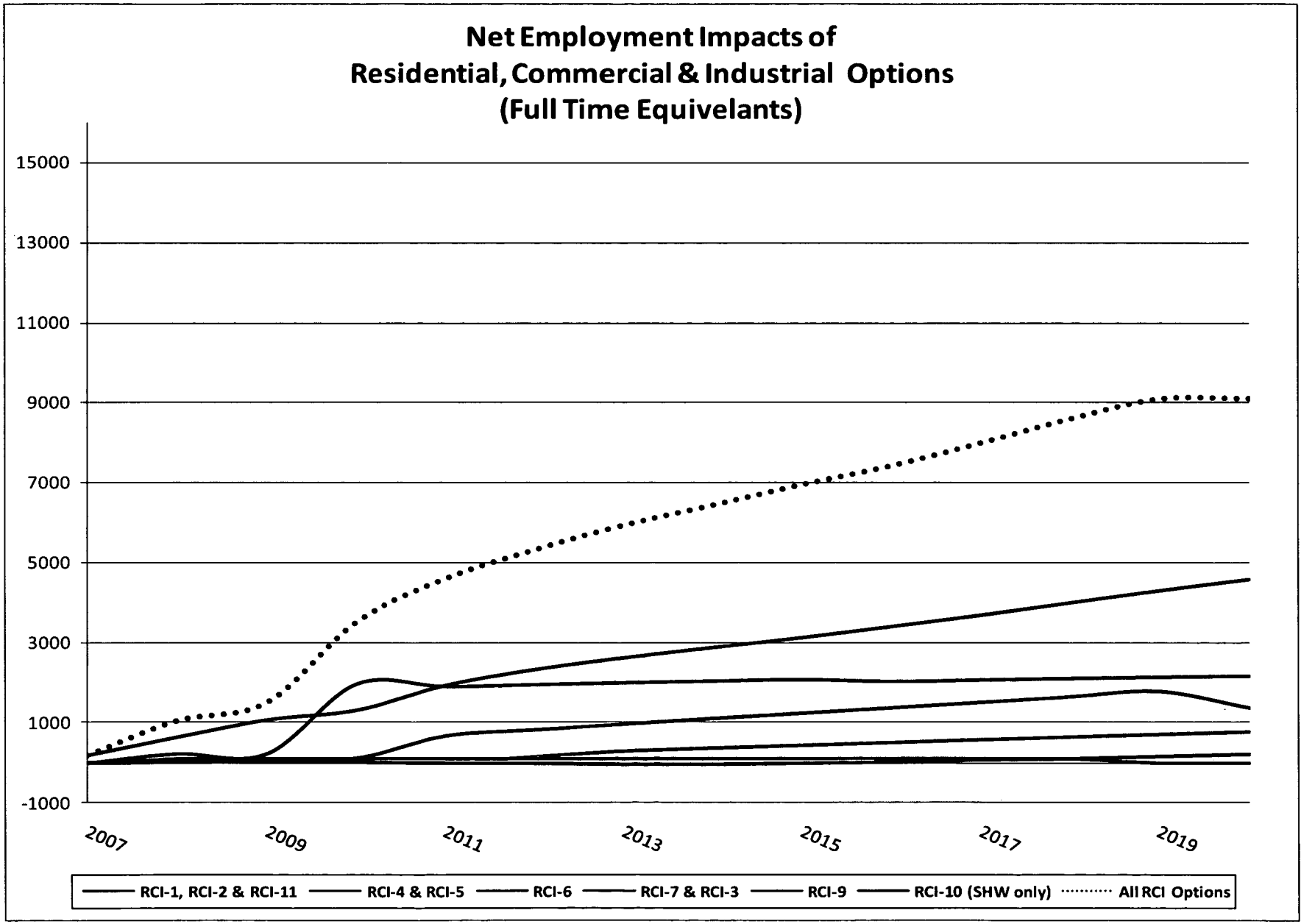
Chapter 3 Results of Residential, Commercial & Industrial Options Analysis

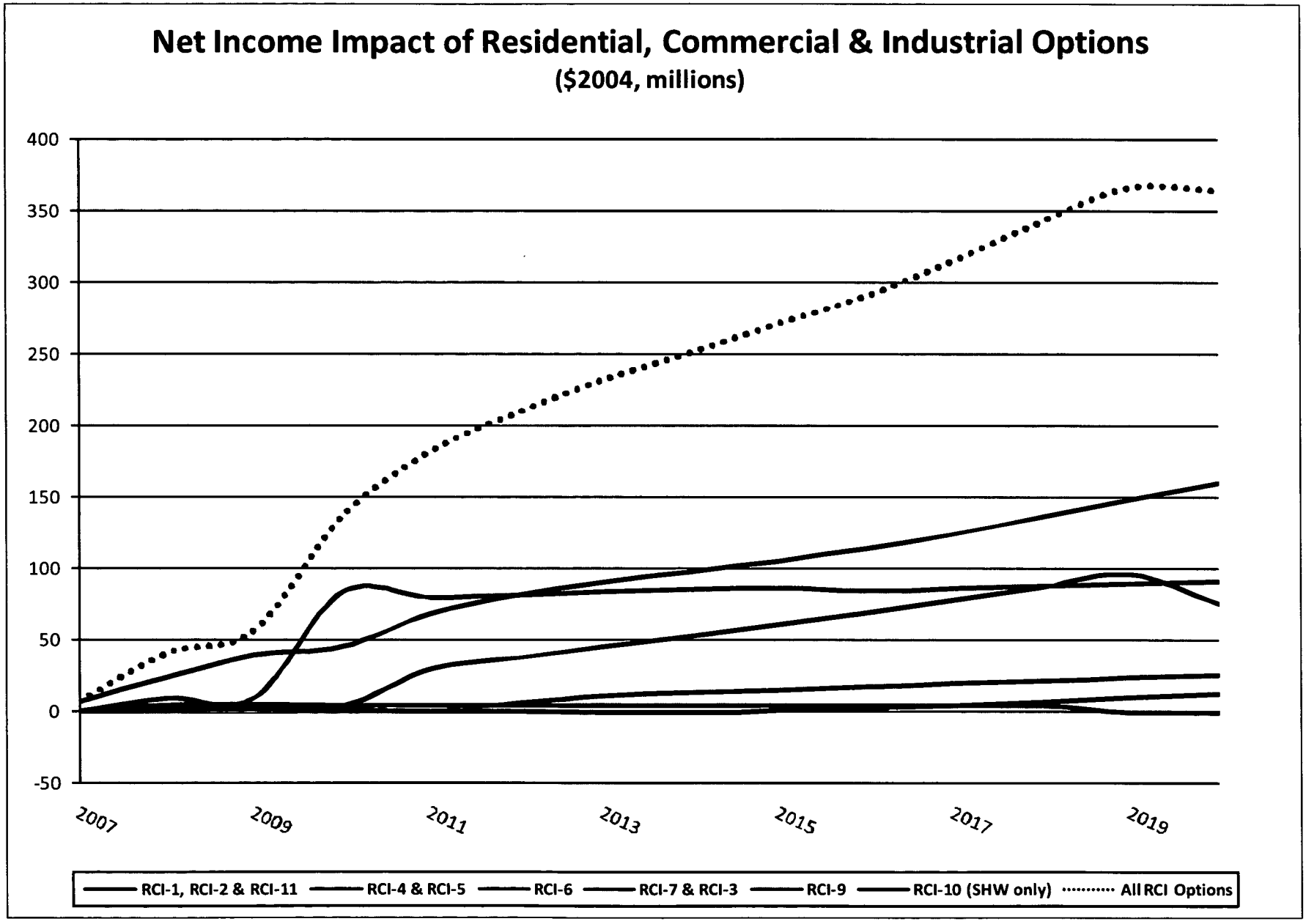
Table 3-1 presents summary results for the RCI mitigation options analyzed. By 2020, these options would result in the net creation of more than 9,100 jobs, $364 million in additional employee and proprietor income, and $42 million in net gross state product. Over the study period, 2007–2020, the options would generate $1.9 billion (NPV) in additional employee and proprietor income and $937 million (NPV) in gross state product. The economic impacts associated with these options are driven primarily by energy bill savings resulting from energy efficiency measures.

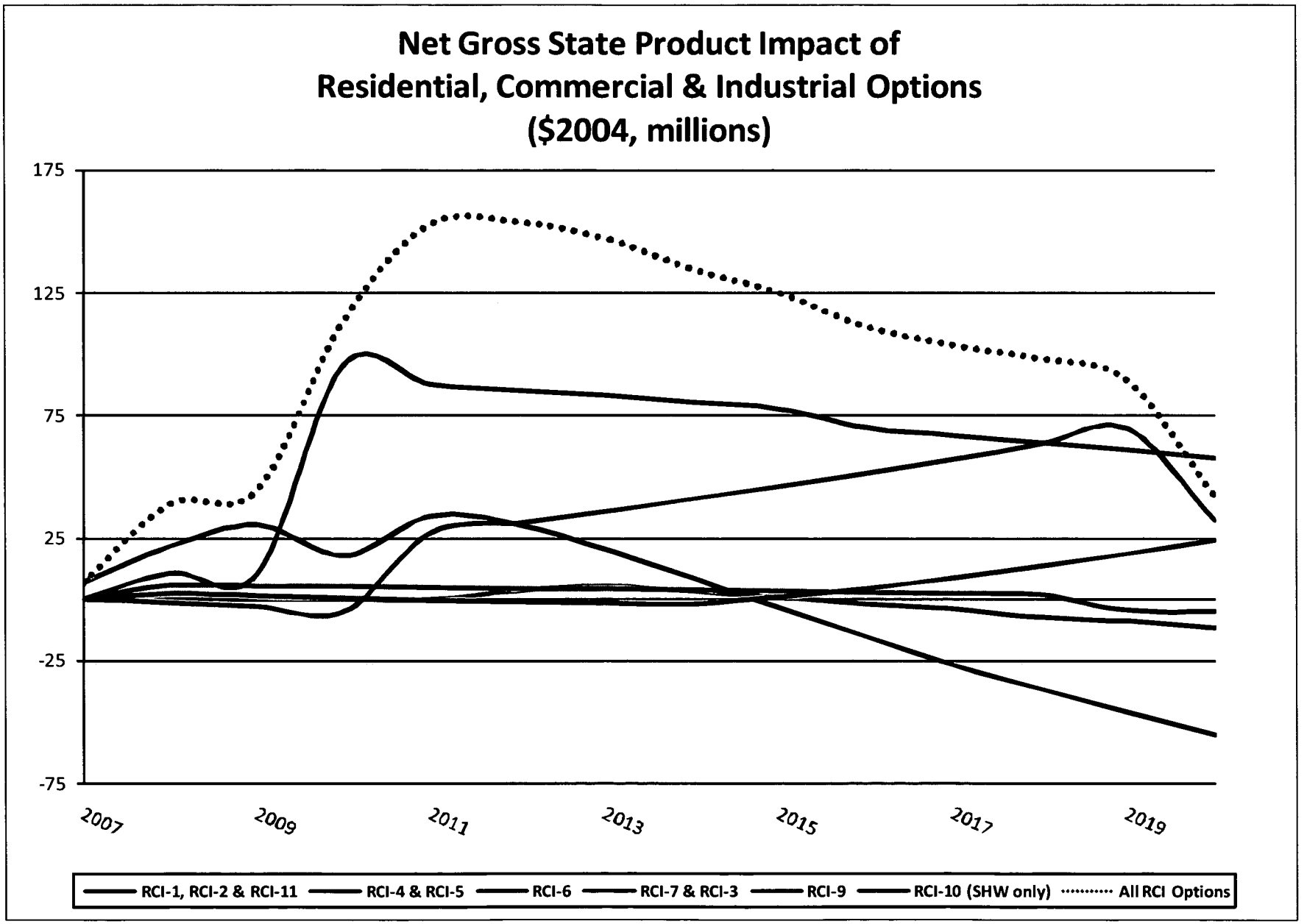
Table 3-1: Summary Results for Residential, Commercial and Industrial Options Analyzed

	Net Annual Employment (FTE)			Net Income ($2004, million)				Total Value-Added ($2004, million)			
Residential, Commercial and Industrial Options	**2010**	**2015**	**2020**	**2010**	**2015**	**2020**	**2007-2020 NPV**	**2010**	**2015**	**2020**	**2007-2020 NPV**
RCI 1, 2 & 11 (Efficiency Funding & Energy Audits)	1,309	3,121	4,575	45	105	160	789	18	(4)	(55)	36
RCI 4 & 5 (Market Transformation & Appliance Standards)	-	430	771	-	15	26	87	-	1	(11)	(9)
RCI 6 (Energy Codes)	1,964	2,076	2,163	83	86	90	623	96	77	57	571
RCI 7 & 3 (High Performance Buildings)	126	1,239	1,372	3	61	76	388	(5)	46	32	273
RCI 9 (Bulk Purchasing & Green Power)	105	99	12	4	4	(1)	33	5	3	(5)	28
RCI 10 (Solar Water Heating)	13	(4)	218	1	0	13	21	0	1	24	37
All RCI Policies	**3,518**	**6,961**	**9,110**	**136**	**271**	**364**	**1,942**	**114**	**125**	**42**	**937**

Note: Values in parentheses identify loss of jobs, income, or Value-Added to the economy. NPV = net present value. FTE=Full Time Equivalent


Net Employment Impacts of
Residential, Commercial & Industrial Options
(Full Time Equivelants)
15000
13000
11000
9000
7000
5000
3000
1000
-1000
2007
2009
2011
2013
2015
2017
2019
RCI-1, RCI-2 & RCI-11
RCI-4 & RCI-5
RCI-6
RCI-7 & RCI-3
RCI-9
RCI-10 (SHW only)
All RCI Options


Net Income Impact of Residential, Commercial & Industrial Options
($2004, millions)
400
350
300
250
200
150
100
50
0
-50
2007
2009
2011
2013
2015
2017
2019
RCI-1, RCI-2 & RCI-11
RCI-4 & RCI-5
RCI-6
RCI-7 & RCI-3
RCI-9
RCI-10 (SHW only)
All RCI Options


Net Gross State Product Impact of
Residential, Commercial & Industrial Options
($2004, millions)
175
125
75
25
-25
-75
2007
2009
2011
2013
2015
2017
2019
RCI-1, RCI-2 & RCI-11
RCI-4 & RCI-5
RCI-6
RCI-7 & RCI-3
RCI-9
RCI-10 (SHW only)
All RCI Options

RCI-1, RCI-2 & RCI-11: Energy Efficiency Funding & Energy Audits

These options propose to establish dedicated funding sources for energy efficiency and conservation measure in order to reduce demand for conventional sources of electricity and natural gas. The mitigation option design of RCI-1 seeks to increase Demand –Side Management Program (DSM) investments to 1.5% of utility revenues by 2012 while RCI-2 seeks to establish a Public Benefits Fund equivalent to 1% of utility revenues by 2010. RCI-11 seeks to direct a portion of these revenues to provide technical assistance visits to residential, commercial, and industrial customers to help identify energy efficiency measures and provide incentives to implement such measures. In consolidating these options for analysis, the ASU Energy Center applied the overlap factors identified by the RCI technical working group.

By 2020, these policies would result in the creation of more than 4,575 jobs, $160 million dollars in annual employee and proprietor income, but the loss of $55 million in annual gross state product. For the study period, 2007-2020, the mitigation options would add $789 million (NPV) in employee and proprietor income and $36 million (NPV) in gross state product. Moreover, the energy efficiency and conservation measures implemented as a result of these policies would continue pay dividends well beyond the study period.

RCI-4 & RCI-5: Market Transformation & Appliance Standards

These measures are intended to spur adoption of energy efficiency technologies through a combination of voluntary market transformation and technology development programs (RCI-4) and mandated improvements in the energy efficiency of consumer electronics, appliances, and equipment (RCI-5). RCI-4 seeks to reduce reference case electricity consumption by .2% a year beginning in 2012 through the establishment of a market transformation program to encourage the adoption of energy efficient products and services similar to the Northwest Energy Efficiency Alliance. RCI-5 calls for the adoption and enforcement of appliance and equipment energy efficiency recommended by the Appliance Standards Awareness Project and the Alliance for an Energy Efficient Economy (ASAP/ACEEE) in the joint 2006 report, "Leading the Way: Continued Opportunities for New State Appliance and Equipment Efficiency Standards." In consolidating these options for analysis, the ASU Energy Center applied the overlap factors identified by the RCI technical working group.

By 2020, these policies would result in the creation of 771 jobs, $26 million dollars in annual employee and proprietor income, but the loss of $11 million in annual gross state product. For the study period, 2007-2020, the mitigation option would add $87 million (NPV) in employee and proprietor income but the loss of $9 million (NPV) in gross state product. Moreover, the energy efficiency and conservation measures implemented as a result of these policies would continue pay dividends well beyond the study period.

RCI-6: Building Codes

This mitigation option seeks to improve compliance with state building energy codes and establish a new code by 2010 that achieves a 20% energy savings over the current national building energy code standards for residential and commercial construction.

By 2020, this mitigation option would result in the creation of more than 2,163 jobs, $90 million dollars in annual employee and proprietor income, and $57 million in annual gross state product. For the study period, 2007-2020, the mitigation option would add $623 million (NPV) in employee and proprietor income and $571 million (NPV) in gross state product.

RCI-7 & RCI-3: High Performance Buildings

These policies seek to encourage advanced construction technologies and the installation of distributed renewable systems in residential, commercial, and government building. RCI-7 calls for the energy performance of 5% of new residential and 2% of new commercial annual construction to exceed the upgraded building energy codes called for in RCI-6 by 30% by 2010 and by 32% by 2020. The mitigation option also calls for 20% existing residential and commercial building stock to meet current building energy codes resulting in performance gains of 20% for commercial buildings and 15% for residential buildings. RCI-3 addresses new state government construction and renovation projects, calling for a 16% reduction in energy consumption for new project and a 12% reduction in existing building beyond the upgraded building codes called for in RCI-6 by 2020. The RCI analysis assumed the performance gains for each mitigation option would be achieved through investments in energy efficiency improvements, solar thermal hot water systems, and on-site photovoltaic installations and on-site bioenergy projects such as biomass, biogas, and landfill gas systems with different implementation rates for each customer class. In consolidating these options for analysis, the ASU Energy Center applied the overlap factors identified by the RCI technical working group.

By 2020, this mitigation option would result in the creation of more than 1,362 jobs, $76 million dollars in annual employee and proprietor income, and $32 million in annual gross state product. For the study period, 2007-2020, the mitigation option would add $388 million (NPV) in employee and proprietor income and $273 million (NPV) in additional gross state product.

RCI-9: Bulk Purchasing for Energy Efficient Appliances & Green Power Purchases for State Agencies

This option calls for the expansion of state government purchases of electricity produced from renewable resources and the establishment of a bulk purchasing program to facilitate the purchase of energy efficient appliances and equipment for both the private and public sectors. The operationalization of the bulk purchasing component of the mitigation option by the RCI technical working group assumes an annual electricity savings of 2% for the public sector and .1% for the private sector by 2018. The green power purchase component sets a goal of 20% of all state agency electricity purchases to be derived from renewable resources by 2018.

By 2020, this mitigation option would result in the creation of 12 jobs but the loss of $1 million dollars in annual employee and proprietor income, and $5 million in annual gross state product. For the study

period, 2007-2020, the mitigation option would increase employee and proprietor income by $33 million (NPV) and gross state product by $28 million (NPV).

RCI 10: Solar Hot Water Heating Only

This mitigation option calls for the installation of distributed renewable and combined heat and power (CHP) systems smaller than 10 MW with goals of a taking advantage of 29% of North Carolina's CHP potential, installing 35 MW of distributed renewable generation, and installing solar hot water heating (SHW) systems in 3% of all homes, all by 2020. Considerable overlap exists between this mitigation option and the CHP option developed by the ES technical working group. Moreover, the CAPAG's final estimate of greenhouse gas emissions reductions only includes the SHW component of RCI-10 and is therefore the only component considered in this study.

By 2020, the SHW component of this mitigation option would result in the net creation of more than 218 jobs, $13 million dollars in annual employee and proprietor income, and $24 million in annual gross state product. For the study period, 2007-2020, the mitigation option would create an additional $21 million (NPV) in employee and proprietor income and $37 million (NPV) in additional gross state product.

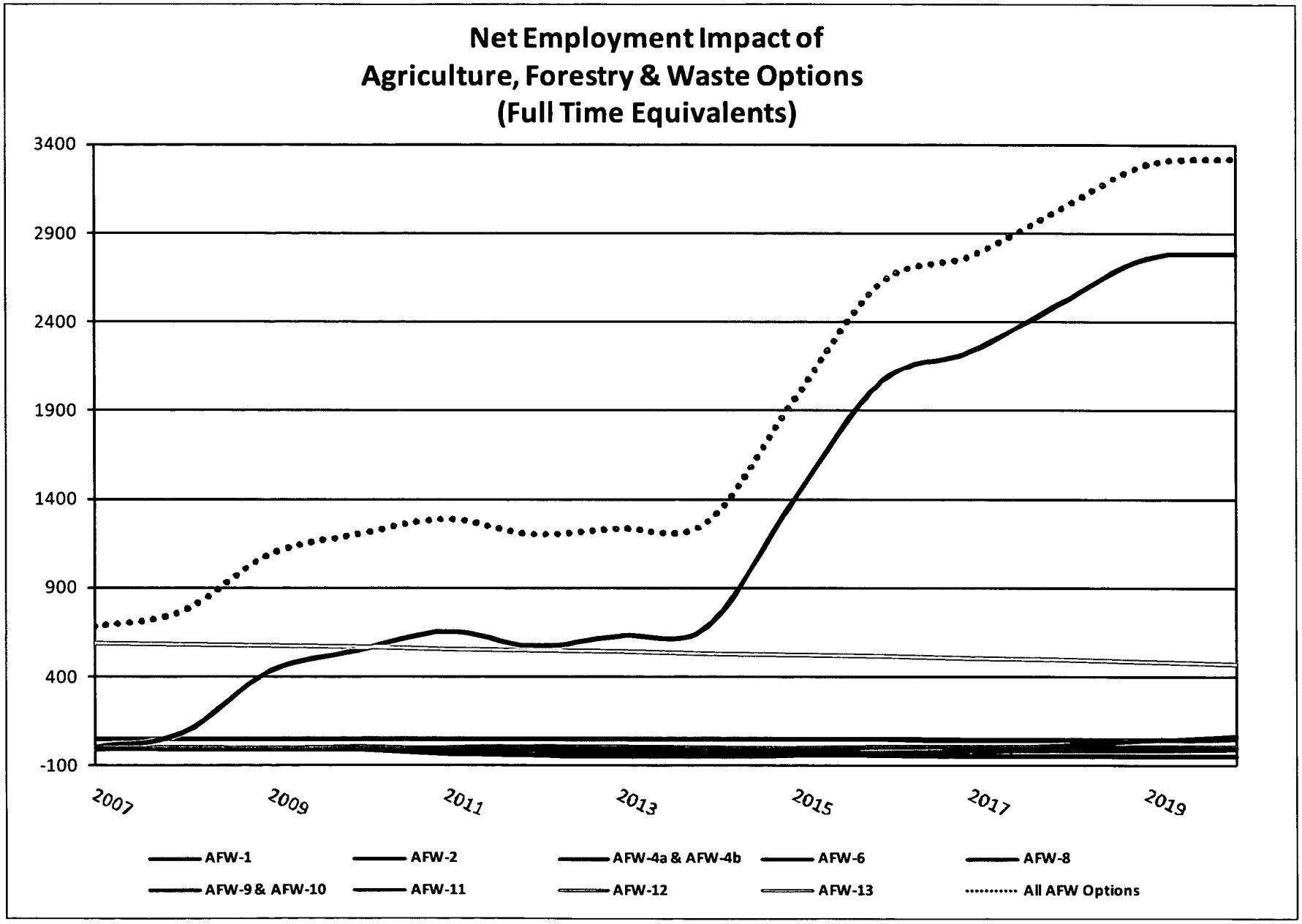
Chapter 4 Analysis Results of Agricultural, Forestry & Waste Management Options

Table 4-1 presents summary results for AFW options analyzed. By 2020, these options would result in the net creation of more than 3,300 jobs, $183 million in additional employee and proprietor income, and $331 billion in gross state product. Over the study period, 2007–2020, the options would generate nearly $649 million (NPV) in additional employee and proprietor income and $1.2 billion (NPV) in gross state product. The positive economic impacts associated with these options are driven primarily by capital investments to build manufacturing capacity to meet the biofuels production goals articulated in the mitigation options.

Table 4-1: Summary Results for Agriculture, Forestry & Waste Management Options Analyzed

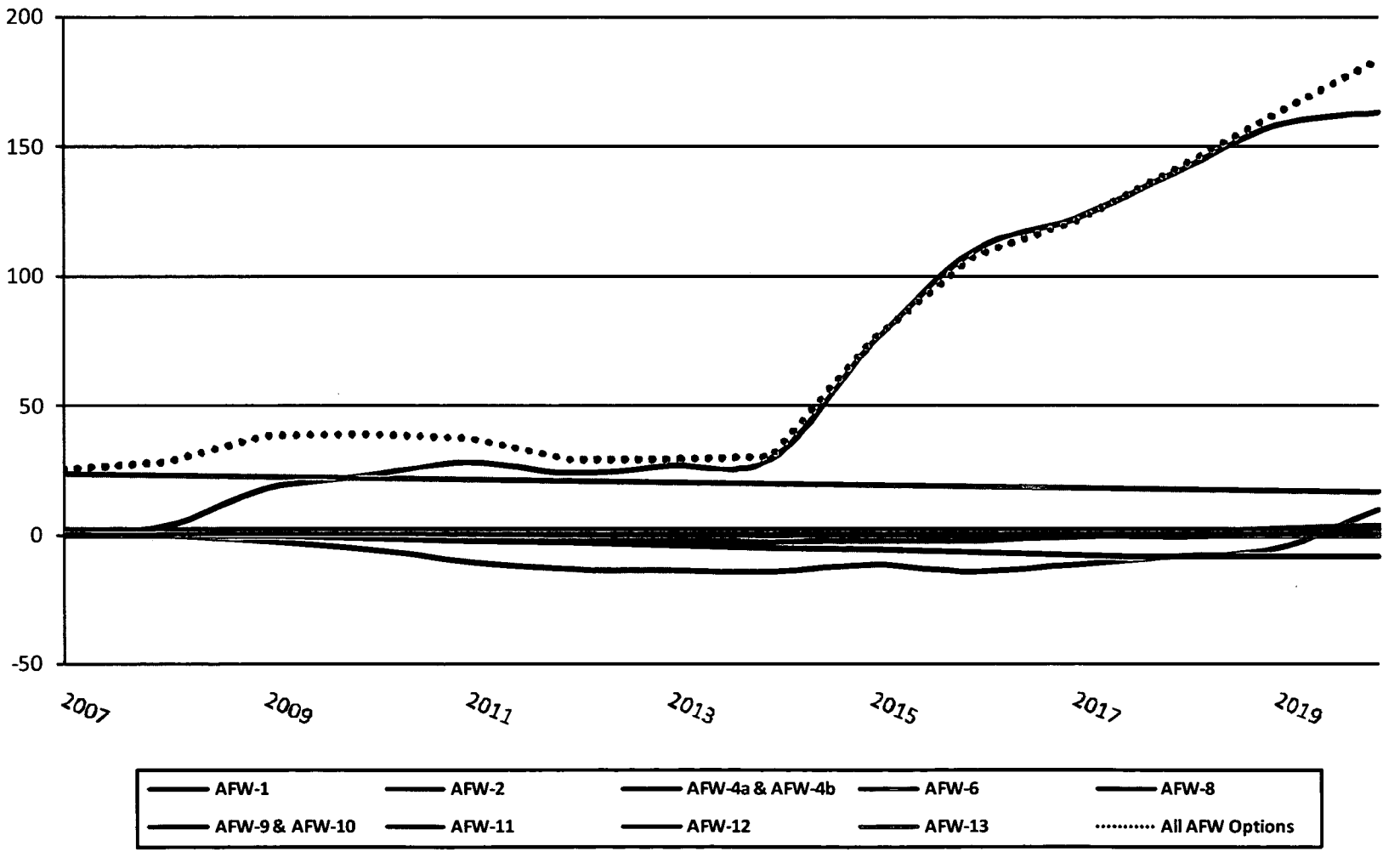
	Net Annual Employment (FTE)			Net Income ($2004, million)				Total Value-Added ($2004, million)			
Agriculture, Forestry and Waste Options	**2010**	**2015**	**2020**	**2010**	**2015**	**2020**	**2007-2020 NPV**	**2010**	**2015**	**2020**	**2007-2020 NPV**
AFW 1 (Manure Digesters)	51	48	53	2	2	2	19	3	2	2	24
AFW 2 (Biodiesel)	51	48	53	(6)	(12)	10	(72)	(7)	(15)	17	(85)
AFW 4a & 4b (Easements)	2	(4)	3	(.2)	(1)	(1)	(4)	1	2	4	18
AFW 6 (Cellulosic Ethanol)	547	1,399	2,781	23	74	163	547	43	135	298	1,016
AFW 8 (Afforestation)	(13)	(45)	66	(1)	(2)	4	(9)	(1)	(3)	8	(8)
AFW 9 & 10 (Forest Management)	(9)	(33)	(48)	(2)	(6)	(9)	(41)	(.1)	(.3)	(.4)	(2)
AFW 11 (Landfill Gas)	(6)	(24)	(5)	(.1)	(1)	0.4	(2)	1	(.3)	2	4
AFW 12 (Recycling)	1	2	6	.1	.1	.3	2	.3	.3	1	3
AFW 13 (Urban Forestry)	566	524	475	22	19	17	106	37	22	8	115
All AFW Policies	**1,202**	**1,960**	**3,318**	**39**	**75**	**183**	**649**	**78**	**145**	**331**	**1,267**

Note: Values in parentheses identify loss of jobs, income, or Value-Added to the economy. NPV = net present value. FTE=Full Time Equivalent


Net Employment Impact of
Agriculture, Forestry & Waste Options
(Full Time Equivalents)
3400
2900
2400
1900
1400
900
400
-100
2007
2009
2011
2013
2015
2017
2019
AFW-1
AFW-2
AFW-4a & AFW-4b
AFW-6
AFW-8
AFW-9 & AFW-10
AFW-11
AFW-12
AFW-13
All AFW Options

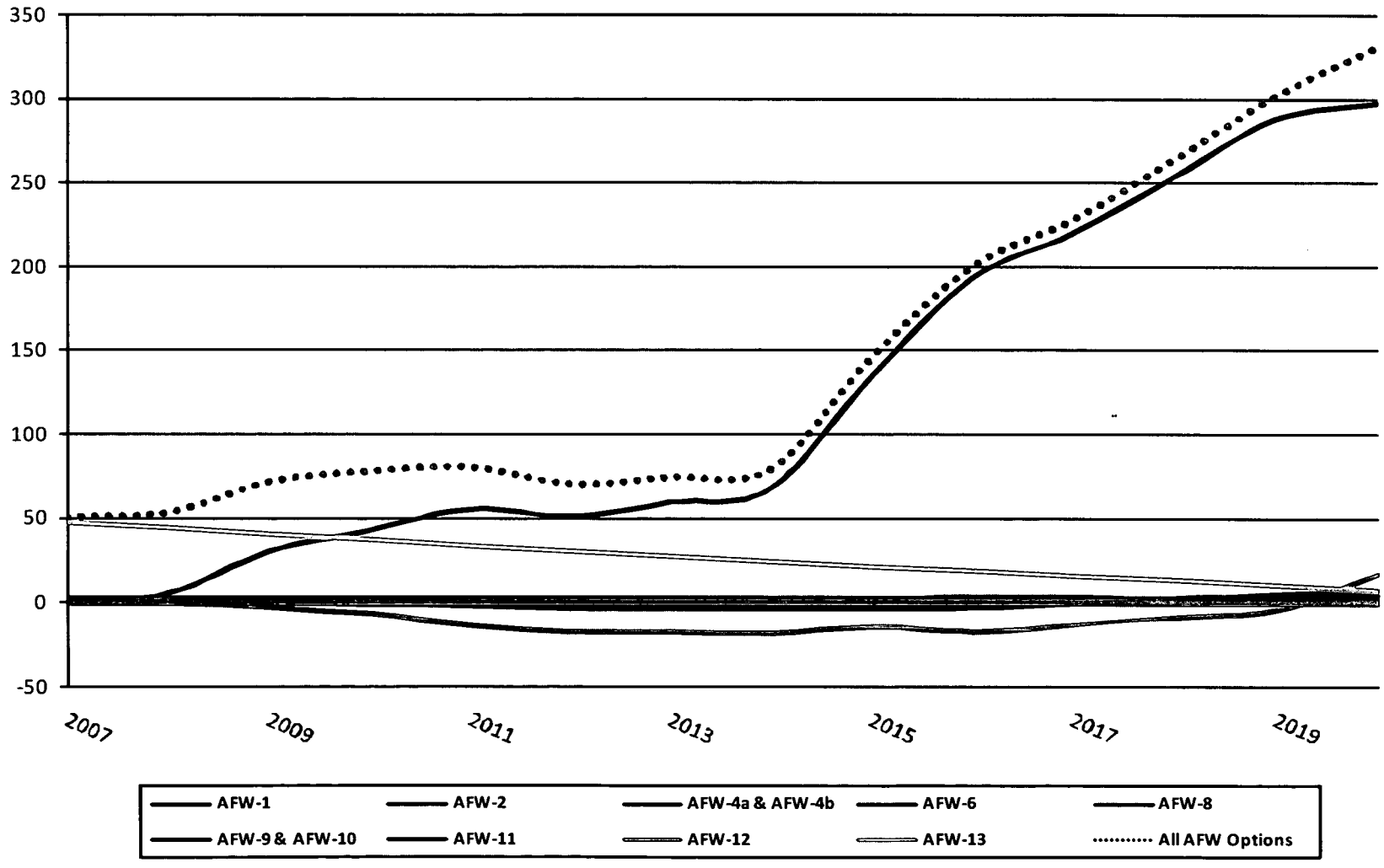
Net Income Impact of Agriculture, Forestry & Waste Management Options

($2004, millions)



Net Gross State Product Impact of Agriculture, Forestry & Waste Management Options

($2004, millions)



AFW-1: Manure Digesters

This option proposes to capture twenty percent of the methane emissions from Concentrated Animal Feeding Operations (CAFO) in North Carolina, such as hog and dairy farms, in order to generate electricity, by 2020. By 2020, this mitigation option would result in the creation of more than 53 jobs, $2 million in additional annual employee and proprietor income, and $2 million in annual gross state product. For the study period, 2007-2020, the mitigation option would generate $19 million (NPV) in additional employee and proprietor income and $24 million (NPV) in gross state product.

AFW-2: Biodiesel Production Subsidy

This option proposes to displace 5% of North Carolina's petroleum diesel fuel consumption with biodiesel by 2010 ramping up to 12.5% by 2020. The option assumes a state subsidy to support biodiesel producers worth $.34 per gallon for the first five years of production in order to drive technological advances that will make biodiesel production costs more competitive with petroleum diesel. Since the AFW technical working group analysis only quantified the cost of the subsidy and not the value of the capital investments and operating expenses, including feedstocks, required to meet the production targets, this study relied on additional research and literature to quantify these values.

When these additional investments are considered, by 2020 this mitigation option would result in the creation of 53 jobs, $10 million in additional annual employee and proprietor income, and $17 million in annual gross state product. For the study period, 2007-2020, the mitigation option would decrease employee and proprietor income by $72 million (NPV) and gross state product by $85 million (NPV). These study period reductions are a function of government subsidy payments displacing other government expenditures and as those payments are phased out, it is likely the effect over a longer horizon would yield a positive impact.

AFW-4A & AFW-4B: Farmland and Forestland Conservation Easements

These options seek to reduce the rate of conversion of North Carolina's forests and farmland to development through public funding of conservation easements. The mitigation option designs articulate a goal of reducing the current rate of conversion by 20% by 2010 and 50% by 2020. By 2020 this mitigation option would result in the creation of 3 jobs and $4 million in annual gross state product but the loss of $1 million in annual employee and proprietor income. For the study period, 2007-2020, the mitigation option would generate $18 million (NPV) in additional gross state product but the loss of $4 million (NPV) in employee and proprietor income.

AFW-6: Cellulosic Ethanol Production Subsidy

This option proposes to displace 10% of North Carolina's gasoline consumption with starch and cellulosic derived ethanol by 2010 ramping up to 25% by 2025. The option assumes a state subsidy to support ethanol producers worth $.23 per gallon through 2015, at which time it is assumed technological advances will make cellulosic ethanol production costs more competitive. Since the AFW technical working group analysis only quantified the cost of the subsidy and not the value of the capital investments and operating expenses, including feedstocks, required to meet the production targets, this study relied on additional research and literature to quantify these values.

When these additional investments are considered, this mitigation option would result in the creation of more than 2,781 jobs, $163 million in additional annual employee and proprietor income, and more than $298 million in annual gross state product by 2020. For the study period, 2007-2020, the mitigation option would increase employee and proprietor income by $547 million (NPV) and gross state product by more than $1 billion (NPV).

AFW-8: Afforestation

This option seeks to convert 540,000 acres of nonforested lands and degraded habitats in North Carolina to forests by 2020 through an expansion of the N.C. Dept of Environment and Natural Resources, Division of Forest Resource's Forest Development Program. The mitigation option design envisions a public subsidy consisting of a 100% cost share rate for establishments worth $140 per acre and a Conservation Reserve Program (CRP)-type payment of $40/acre for five years. Since the AFW technical working group analysis only quantified the cost of the subsidy and not the change in value of rent payments for forested lands, this study relied on additional research and literature to quantify these values.

When these changes in rent are considered, this mitigation option would result in the creation of 66 jobs, $4 million in additional annual employee and proprietor income, and $8 million in annual gross state product by 2020. For the study period, 2007-2020, the mitigation option would decrease employee and proprietor income by $9 million (NPV) and gross state product by $8 million (NPV).

AFW-9 & AFW-10: Forest Management

These options seek to increase forest stand productivity through intensive forest management practices with a goal of doubling forest productivity on half of North Carolina timberlands by 2020 through an expansion of the N.C. Dept of Environment and Natural Resources, Division of Forest Resource's Forest Development Program. To achieve this goal the mitigation option design assumes a state investment of $8.80 per acre per year. The AFW technical working group analysis assumes these investments would result in additional revenues from hardwood forest products sales worth of a future value of $390 per acre.

By the year 2020, this mitigation option would result in the loss of 48 jobs, $9 million in annual employee and proprietor income, and $.4 million in annual gross state product. For the study period, 2007-2020, the mitigation option would decrease employee and proprietor income by $41 million (NPV) and gross state product by $2 million (NPV).

AFW-11: Landfill Gas

This option proposes to capture fifty percent of the methane emissions from North Carolina's solid waste facilities for energy use by 2020. The mitigation option design assumes that 63% of the captured landfill gas (LFG) will be used to fuel small engine generators to produce electricity, 20% will be used in direct use applications, and 17% will be used to fuel standard engine generators. By 2020 this mitigation option would result in the loss of 5 jobs but the creation of $.4 million in additional annual employee and proprietor income and $2 million in annual gross state product. For the study period, 2007-2020, the mitigation option would result in the loss of $2 million (NPV) in employee and proprietor income but the creation of $4 million in gross state product.

AFW-12: Recycling

This option seeks to increase per capita recycling rates in North Carolina above current levels by 10% by 2010 and 25% by 2020 through expansion of curbside collection programs and enhancement of educational programs. By 2020 this mitigation option would result in the creation of 6 jobs, $.3 million dollars in annual employee and proprietor income, and $1 million in annual gross state product. For the study period, 2007-2020, the mitigation option would create $2 million (NPV) in employee and proprietor income and $3 million (NPV) in gross state product.

AFW-13: Urban Forestry

This option seeks to increase urban tree cover by planting three additional trees on all new residential construction sites starting in 2008, and by planting three new additional trees at one quarter of existing housing units by 2020, with the goal of achieving a $150 per unit per year in energy savings. By 2020, this mitigation option would result in the creation of more than 475 jobs, $17 million dollars in annual employee and proprietor income, and $8 million in annual gross state product. For the study period, 2007-2020, the mitigation option would add $649 million (NPV) in employee and proprietor income and $115 million (NPV) in gross state product.

Chapter 5 RESULTS OF TRANSPORTATION AND LAND USE OPTIONS ANALYSIS

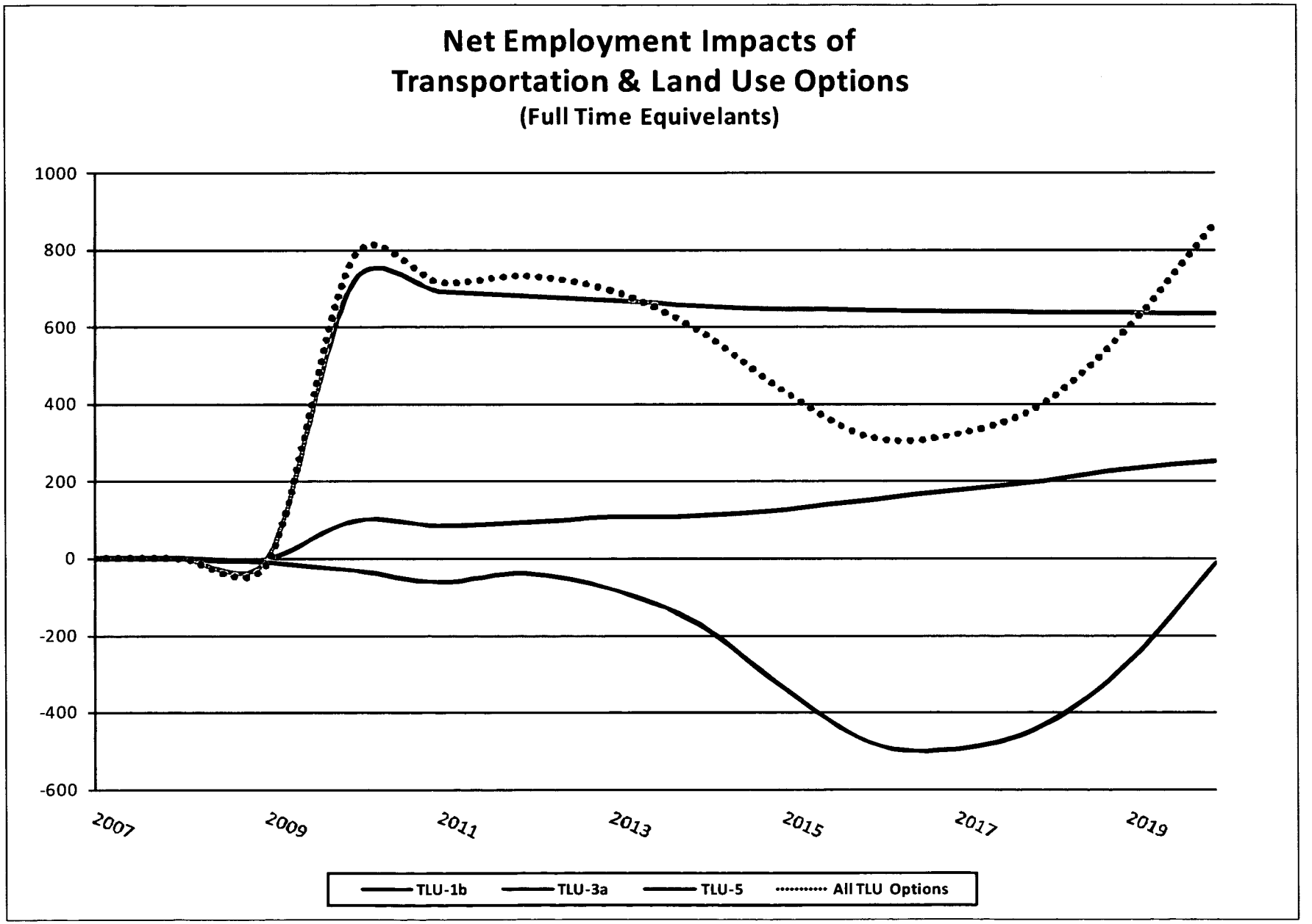
Table 5-1 presents summary results for Transportation and Land Use options analyzed. By 2020, these options would result in the creation of more than 870 net jobs and $48 million in net gross state product but the loss of $8 million in employee and proprietor income. Over the study period, 2007–2020, the options would generate $128 million (NPV) in gross state product but the loss of $91 million (NPV) in employee and proprietor income. The bulk of the economic impacts associated with these options are driven by consumer re-spending of reduced vehicle operating costs.

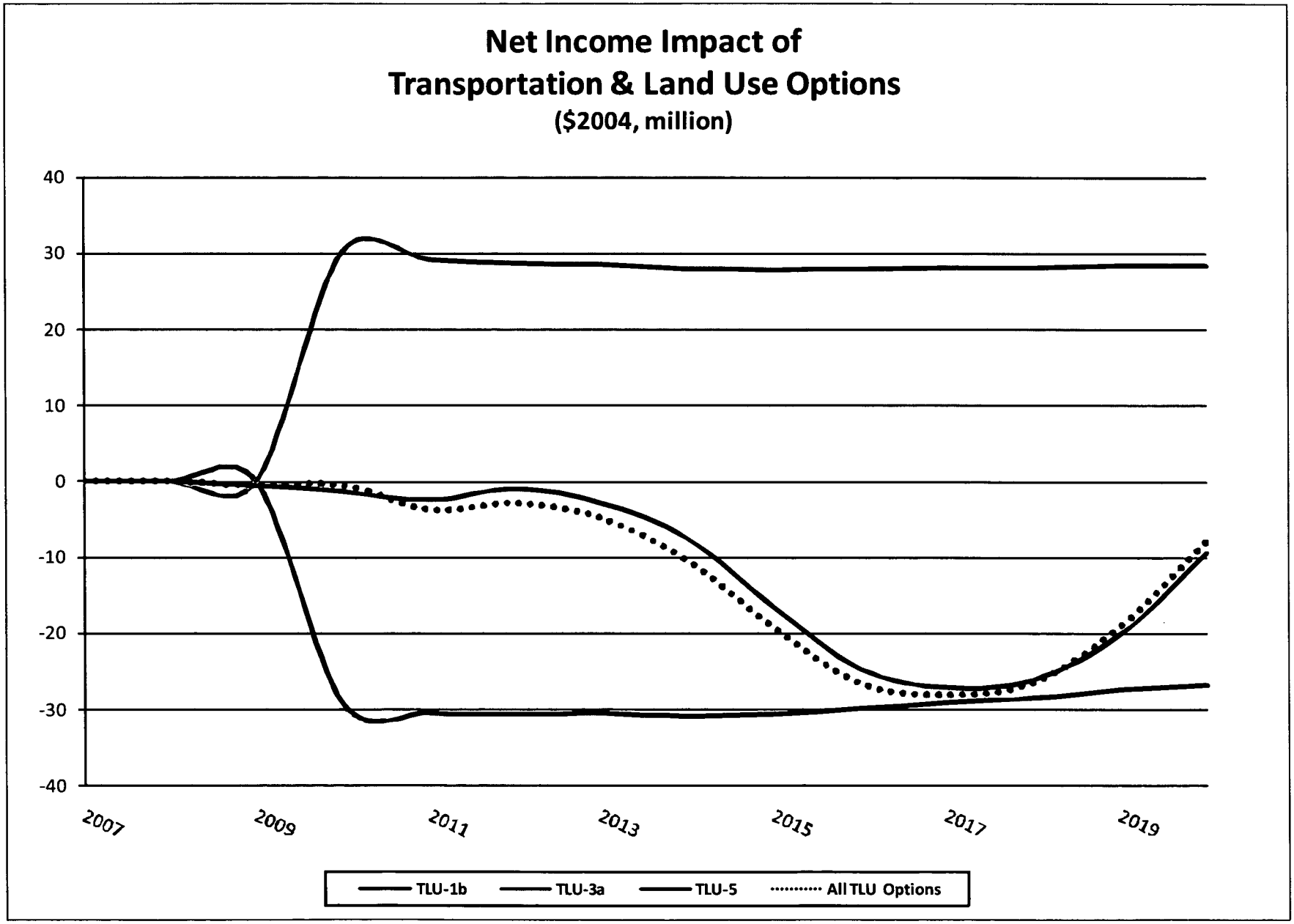
The negative impacts associated with TLU-5 are largely the result of the relative effect of reduced vehicle operating costs versus the displacement of retail gasoline sales. While TLU-5 results in a net savings to vehicle owners, the positive multiplier effect of these savings do not outweigh the constrictive multiplier effect of displaced retail gasoline sales. However, it should be noted that the modeling assumptions of this option are intentionally conservative. For example, it assumes as the U.S. Energy Information Administration's 2007 regional retail fuel price forecast for gasoline, which averages $2.21 per gallon over the study period and is considerably lower than the current market prices. Variability in the baseline fuel price assumption is considered and discussed in Chapter 6. These sensitivities suggest that if energy prices remain at, or near, their recent highs then vehicle greenhouse emissions standards would result in substantial positive economic impacts.

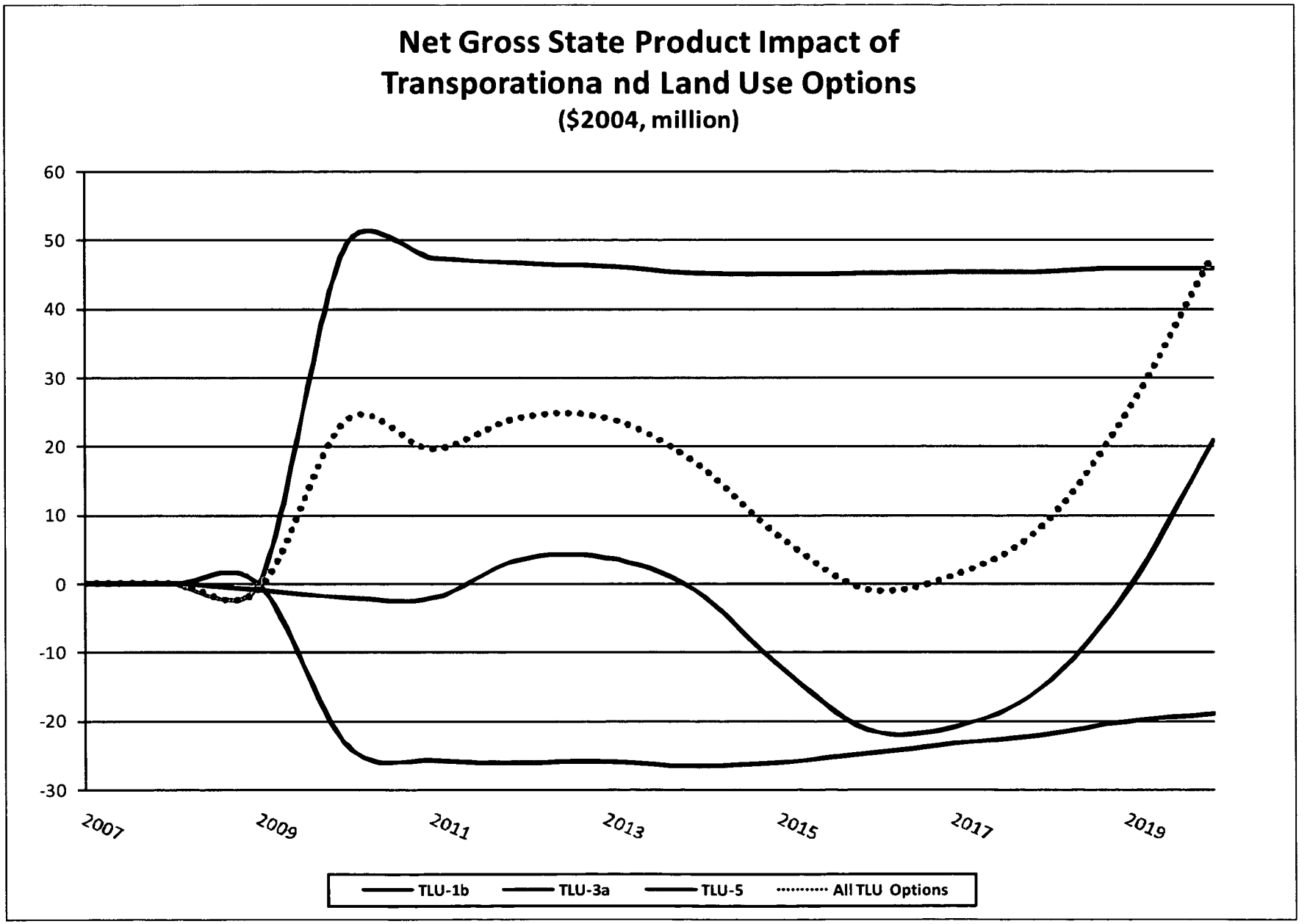
Table 5-1: Summary Results for Transportation and Land Use Options Analyzed

	Net Annual Employment (FTE)			Net Income ($2004, million)				Total Value-Added ($2004, million)			
Transportation and Land Use Options	**2010**	**2015**	**2020**	**2010**	**2015**	**2020**	**2007-2020 NPV**	**2010**	**2015**	**2020**	**2007-2020 NPV**
TLU 1b (Shift to Transit Spending)	98	127	252	(29)	(31)	(27)	(213)	(23)	(26)	(19)	(173)
TLU 3a (Registration Surcharge)	718	646	632	30	28	28	205	49	45	46	332
TLU 5 (Vehicle GHG Standard)	(32)	(341)	(14)	(1)	(17)	(9)	(83)	(2)	(12)	21	(31)
All TLU Policies	**783**	**432**	**871**	**(1)**	**(19)**	**(8)**	**(91)**	**24**	**7**	**48**	**128**

Note: Values in parentheses identify loss of jobs, income, or Value-Added to the economy. NPV = net present value. FTE=Full Time Equivalent


Net Employment Impacts of
Transportation & Land Use Options
(Full Time Equivelants)
1000
800
600
400
200
0
-200
-400
-600
2007
2009
2011
2013
2015
2017
2019
TLU-1b
TLU-3a
TLU-5
All TLU Options


Net Income Impact of
Transportation & Land Use Options
($2004, million)
40
30
20
10
0
-10
-20
-30
-40
2007
2009
2011
2013
2015
2017
2019
TLU-1b
TLU-3a
TLU-5
All TLU Options


Net Gross State Product Impact of
Transporationa nd Land Use Options
($2004, million)
60
50
40
30
20
10
0
-10
-20
-30
2007
2009
2011
2013
2015
2017
2019
TLU-1b
TLU-3a
TLU-5
All TLU Options

TLU-1B: Multi-modal Transportation and Promotion

This mitigation option recommends shifting 13% of North Carolina's transportation funding from spending on highway & roads to multi-modal transportation projects such as bus service, passenger and commuter rail, and bicycle and pedestrian programs starting in 2010, per the recommendations in the N.C. Department of Transportation's (DOT) *Long-Range Statewide Multimodal Transportation Plan*. The TLU technical working group analysis assumes a constant budget for the N.C. DOT over the study period of $2.5 billion a year, yielding a $325 million a year investment in multi-modal transportation projects. Furthermore, the TLU technical working group assumed this shift in spending would result in a 2.97% reduction in vehicle miles traveled (VMT) by light duty vehicles (LDV) by 2010 and a 2.76% reduction LDV VMT by 2020.

By 2020, this mitigation option would result in the net creation of 252 jobs but the loss of $27 million in annual employee and proprietor income and $19 million in annual gross state product. For the study period, 2007-2020, the mitigation option would reduce employee and proprietor income by $213 million (NPV) but increase net gross state product by $173 million (NPV).

TLU-3A: Vehicle Registration Surcharge to Fund Multi-modal Transportation

This mitigation option recommends establishing a variable surcharge to motor vehicle registration fees in order to fund multi-modal transportation projects such as bus service, passenger and commuter rail, and bicycle and pedestrian programs, starting in 2010. The amount of the surcharge would vary based on a vehicle's fuel economy and emissions performance. The TLU working group assumed such a program would raise $37 million per year and would result in a 1.5% reduction in vehicle miles traveled (VMT) by light duty vehicles (LDV) by 2010 and a 2.5% reduction LDV VMT by 2020.

By 2020, this mitigation option would result in the net creation of 632 jobs, $28 million in annual employee and proprietor income, and $46 million in annual gross state product. For the study period, 2007-2020, the mitigation option would increase employee and proprietor income by $205 million (NPV) and net gross state product by $332 million (NPV).

TLU-5: Tailpipe Greenhouse Gas Emissions Standards

This mitigation option contemplates adoption of regulations to reduce the greenhouse gas emissions associated with operating a motor vehicle similar to those adopted by California and sixteen other states. By 2020, this mitigation option would result in the net loss of 14 jobs and $9 million in annual employee and proprietor income but create $21 million in annual gross state product. For the study period, 2007-2020, the mitigation option would decrease employee and proprietor income by $83 million (NPV) and net gross state product by $31 million (NPV).

Chapter 6 SENSITIVITY ANALYSES

In addition to the baseline scenarios presented in the previous chapters, the ASU Energy Center prepared a set of sensitivity analyses for two individual options. These sensitivities reveal how changes in the baseline scenario assumptions may impact results.

RCI-1: ENERGY EFFICIENCY FUNDING SENSITIVITIES

This option seeks to increase investments in energy efficiency and Demand-side Management (DSM) to 1.5% of utility revenues by 2012. The ASU Energy Center conducted sensitivity analyses for three key variables for this option: program effectiveness, portion of local investment, and the NCESEIM employment multipliers.

PROGRAM EFFECTIVENESS

The RCI TWG assumed that every dollar spent on energy efficiency and DSM programs would result in 8 kilowatt-hours of incremental first-year energy savings. The Energy Center considered sensitivities of this key variable of 10% more energy savings, 25% more energy savings, 10% less energy savings, and 25% less energy savings. Table 6-1 presents summary results for the baseline scenario, as well as, each sensitivity analyzed.

Table 6-1: RCI-1 Program Effectiveness Sensitivities

	Net Annual Employment (FTE)			Net Income ($2004, million)				Total Value Added ($2004, million)			
	2010	2015	2020	2010	2015	2020	2007-2020 NPV	2010	2015	2020	2007-2020 NPV
Base Case	763	2,062	3,068	25	69	108	516	8	(3)	(37)	15
10% More Energy Savings	836	2,244	3,352	28	75	117	560	9	(3)	(41)	13
25% More Energy Savings	946	2,517	3,777	32	84	132	626	11	(5)	(47)	9
10% Less Energy Savings	690	1,880	2,784	23	64	98	472	6	(2)	(32)	17
25% Less Energy Savings	580	1,606	2,359	19	55	83	405	4	(0)	(26)	20

As the bulk of the job creation associated with option is driven by consumer and industry re-spending of energy bill savings, job, income, and total value-added creation depends directly on program effectiveness. This pattern likely holds true for other energy efficiency related options as well.

LOCAL INVESTMENT

The baseline scenario assumes that 90% of the program spending would occur within the North Carolina Economy, based on a weighted average of IMPLAN regional purchase coefficients for the affected sectors. The Energy Center also considered sensitivities of 95% local program spending, 85% local program spending, 80% local program spending, and 75% local program spending. Table 6-2 presents summary results for the baseline scenario, as well as, each sensitivity analyzed. Intuitively, as the share of local investment declines so does the effect on the local economy.

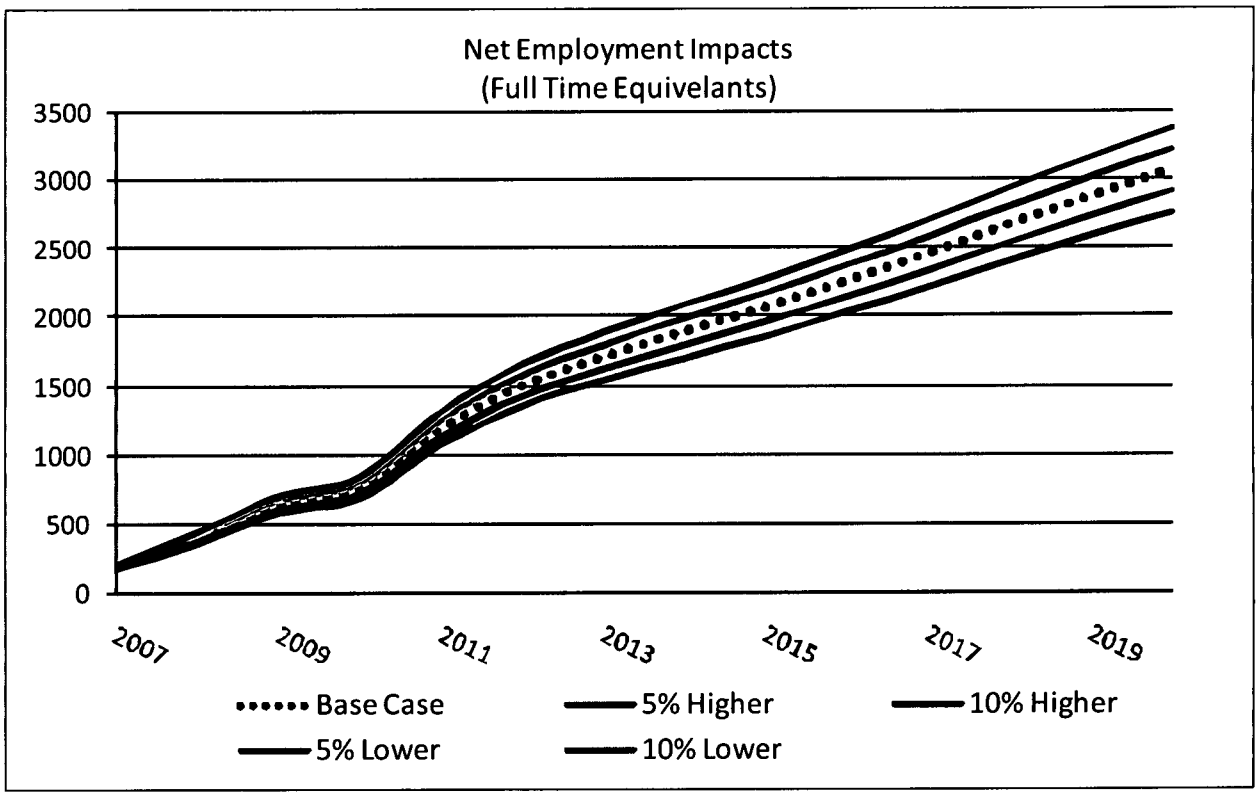
Table 6-2: RCI-1 Local Investment Sensitivities

	Net Annual Employment (FTE)			Net Income ($2004, million)				Total Value Added ($2004, million)			
	2010	2015	2020	2010	2015	2020	2007-2020 NPV	2010	2015	2020	2007-2020 NPV
Base Case (90% local)	763	2,062	3,068	25	69	108	516	8	(3)	(37)	15
95% local	855	2,206	3,217	30	77	116	573	14	9	(24)	99
85% local	671	1,917	2,920	21	62	99	458	1	(14)	(49)	(70)
80 % local	579	1,773	2,771	17	55	91	401	(5)	(25)	(61)	(154)
75% local	487	1,628	2,623	12	47	82	344	(11)	(36)	(74)	(239)

Employment Multipliers

The baseline employment multipliers were derived scenario from state-level data for 2004 compiled by the Minnesota IMPLAN Group as spelled out in Appendix A. The Energy Center also examined the effect of changing the underlying multipliers in the input-output framework by looking at 5% higher, 10% higher, 5% lower, and 10% lower employment multipliers. Figure XX shows the effects of adjusting the employment multipliers and reveals no substantial change in orders of magnitude, a pattern that likely holds true for other options and multipliers.

Figure 6-1: RCI-1Employment Multiplier Sensitivities



TLU-5: GHG Standards for Automobiles Sensitivities

This mitigation options calls for the adoption of California's GHG tailpipe emission standards which require light duty motor vehicles to reduce GHG emissions 36% per mile by 2016. The ASU Energy Center conducted sensitivity analyses for two key variables for this option: compliance cost and fuel price.

Compliance Cost

The baseline scenario adopts the California Air Resource Board's (CARB) estimate of the cost of compliance for the passenger cars and small trucks/sport utility vehicles (SUVs) to calculate the increased costs of the regulation borne by the consumer. While some suggest that both regulators and the automobile industry actually tend to *overstate* the cost of complying with pollution standards (see Hwang and Doniger 2004), the ASU Energy Center considered compliance cost sensitivities of 110%, 125% and 150% of the baseline scenario. Table 6-3 presents summary results for the baseline scenario, as well as, each sensitivity analyzed.

Table 6-3: TLU-5 Compliance Cost Sensitivities

	Net Annual Employment (FTE)			Net Income ($2004, million)				Total Value Added ($2004, million)			
	2010	2015	2020	2010	2015	2020	2007-2020 NPV	2010	2015	2020	2007-2020 NPV
Base Case	(32)	(341)	(14)	(1)	(17)	(9)	(83)	(2)	(12)	21	(31)
10% Higher Compliance Cost	(37)	(503)	(344)	(2)	(25)	(27)	(137)	(2)	(25)	(8)	(120)
25% Higher Compliance Cost	(45)	(746)	(839)	(2)	(37)	(54)	(219)	(3)	(45)	(52)	(254)
50% Higher Compliance Cost	(58)	(1,152)	(1,664)	(3)	(57)	(98)	(355)	(4)	(78)	(125)	(477)

Higher compliance costs may result in modest economic losses; as the cost of pollution controls exceed any vehicle operating savings from fuel efficiency resulting with a resulting contraction in household spending. However, it should be noted that these sensitivities also amplify the effect of the modeling's conservative assumption that additional compliance costs have no effect on local manufacturing.

Fuel Prices

Notably, the baseline scenario is predicated on Energy Information Administration's 2007 regional retail fuel price forecast for gasoline, which averages $2.21 per gallon over the study period and is considerably lower than the current market prices; therefore, the ASU Energy Center considered fuel price sensitivities of 110%, 125% and 150% above the baseline scenario, or, respectively, averages of $2.43, $2.76, and $3.32 per gallon over the study period. Table 6-4 presents summary results for the baseline scenario, as well as, each sensitivity analyzed.

Table 6-4: -5 Fuel Price Sensitivities

	Net Annual Employment (FTE)			Net Income ($2004, million)				Total Value Added ($2004, million)			
	2010	2015	2020	2010	2015	2020	2007-2020 NPV	2010	2015	2020	2007-2020 NPV
Base Case ($2.21/gln)	(32)	(341)	(14)	(1)	(17)	(9)	(83)	(2)	(12)	21	(31)
10% Higher ($2.43/gln)	(30)	(212)	315	(1)	(10)	7	(37)	(2)	(0)	52	55
25% Higher ($2.76/gln)	(28)	(20)	808	(1)	(1)	32	32	(2)	18	99	184
50% Higher ($3.32/gln)	(23)	301	1,629	(1)	15	74	147	(1)	48	177	399

As expected, the fuel price sensitivities result in greater job, income, and total value added creation since higher fuel prices result in larger vehicle operating cost savings and suggests that if energy prices remain at or near their recent highs then vehicle greenhouse emissions standards would actually result in the positive economic impacts.

Chapter 7 QUANTIFICATION OF UPFRONT INVESTMENT COSTS

In addition to the economic impact analysis, CCS requested a summary of the potential annual upfront public and private investments associated with the mitigation options (Table 7-1). The annual investment costs associated with the options are based on the methods used to estimate the costs or cost savings of each option analyzed during the CAPAG process, and supplemental research conducted by the ASU Energy Center in the course of conducting the economic impact analysis.

While implementation of some of the mitigation options may require significant upfront investments of public and/or private resources, these investments, in many cases, also result in significant savings over time. Moreover, many of the mitigation options result in ongoing savings beyond the period included in the CAPAG and ASU Energy Center analyses. Finally, almost all of these initial investment costs will be financed over time reducing the actual annual costs borne by the public and private sectors.

Consider for example TLU-5 (Tailpipe GHG Standards). As noted above, this mitigation option would require automakers to install additional pollution control technologies increasing the purchase price of a new vehicle and monthly car payments. However these same pollution control technologies will increase fuel economy and reduce the vehicle operating expenses, which tend to offset the increased purchase price.

Table 7-1: Projected Potential Upfront Investment Costs of Mitigation Options ($million, 2005)

Energy Supply Options	2010	2015	2020	2007–2020 (NPV)
ES-1 (Renewable Energy Incentives)				
Private investment	10	61	124	414
Public investment	1	2	2	13
Total investment	10	63	127	426
ES-2 (Environmental Portfolio Standard, SB3 Analysis)				
Private investment	-	676	911	4,310
Total investment	-	676	911	4,310
ES-3 & 9 (Combined Heat and Power)				
Private investment	238	396	570	3,082
Total investment	238	396	570	3,082
ES-6a (IGCC versus new pulverized coal)				
Private investment	47	9	9	195
Total investment	47	9	9	195
ES-6b (IGCC displacing existing pulverized coal)				
Private investment	318	69	69	1,353
Total investment	318	69	69	1,353
ES-8 (Municipal Biogas)				
Public investment	0.2	1	3	9
Total investment	-	1	3	9
ALL ES POLICIES				
PRIVATE INVESTMENT	**613**	**1,211**	**1,686**	**9,037**
PUBLIC INVESTMENT	**1**	**3**	**5**	**21**
TOTAL INVESTMENT	**614**	**1,214**	**1,692**	**9,058**

Residential, Commercial and Industrial Options	2010	2015	2020	2007–2020 (NPV)
RCI-1 (Efficiency Funding)				
Private investment	208	329	368	2,527
Total investment	208	329	368	2,527
RCI-2 (1% PBF)				
Private investment	146	154	173	1,242
Total investment	146	154	173	1,242
RCI-11 (Energy Audits)				
Private investment	9	10	10	84
Total investment	9	10	10	84
RCI-4 (Market Transformation)				
Private investment	-	8	19	53
Total investment	-	8	19	53
RCI-5 (Appliance Standards)				
Private investment	-	25	25	141
Total investment	-	25	25	141
RCI-6 (Energy Codes)				
Private investment	225	227	231	1,640
Total investment	225	227	231	1,640
RCI-3 (Energy Efficient Government Buildings)				
Public investment	-	63	71	397
Total investment	-	63	71	397
RCI-7 (High-Performance Buildings)				
Private investment	56	93	93	671
Total investment	56	93	93	671
RCI-9 (Bulk Purchasing & State Government Green Power Purchases)				
Private investment	59	59	-	470
Public investment	2	4	5	26
Total investment	**61**	**63**	**5**	**496**
RCI-10 (Residential Solar Hot Water Heating Only)				
Private investment	37	41	44	351
Total investment	37	41	44	351
ALL RCI POLICIES				
PRIVATE INVESTMENT	**740**	**947**	**964**	**7,188**
PUBLIC INVESTMENT	**1.686**	**66**	**76**	**423**
TOTAL INVESTMENT	**742**	**1,014**	**1,040**	**7,611**

Agriculture, Forestry, and Waste Management Options	2010	2015	2020	2007–2020 (NPV)
AFW-1 (Manure Digesters)				
Private investment	19	28	39	238
Total investment	**19**	**28**	**39**	**238**
AFW-2 (Biodiesel)				
Private investment	45	88	93	414
Public investment	24	49	15	273
Total investment	69	138	107	686
AFW-4a (Farmland Easements)				
Public investment	21	31	51	263
Total investment	**21**	**31**	**51**	**263**
AFW-4b (Forestland Easements)				
Public investment	8	14	20	107
Total investment	8	14	20	107
AFW-5 (Biomass Subsidy)				
Public investment	3	-	-	10
Total investment	3	-	-	10
AFW-6 (Cellulosic Ethanol)				
Private investment	188	339	742	3,008
Public investment	25	-	-	190
Total investment	213	339	742	3,198
AFW-8 (Afforestation)				
Public investment	3	15	15	98
Total investment	3	15	15	98
AFW-9 & -10 (Forest Management)				
Public investment	16	54	78	358
Total investment	16	54	78	358
AFW-11 (Landfill Gas)				
Private investment	12	12	15	112
Total investment	12	12	15	112
AFW-12 (Recycling)				
Private investment	6	10	15	79
Total investment	6	10	15	79
AFW-13 (Urban Forestry)				
Private investment	96	84	76	896
Total investment	96	84	76	896
ALL AFW POLICIES				
PRIVATE INVESTMENT	**382**	**616**	**1,057**	**5,105**
PUBLIC INVESTMENT	**81**	**167**	**255**	**1,353**
TOTAL INVESTMENT	**463**	**784**	**1,312**	**6,459**

Transportation and Land Use Options	2010	2015	2020	2007–2020 (NPV)
TLU-1b (Shift to Transit Spending)				
Public investment	347	347	347	2,487
Total investment	358	358	358	2,572
TLU-3a (Registration Surcharge for Transit $)				
Public investment	33	33	33	239
Total investment	34	34	34	247
TLU-5 (CO_2 Tailpipe Standard)				
Private investment	26	401	553	2,341
Total investment	26	401	553	2,341
ALL TLU OPTIONS				
PRIVATE INVESTMENT	**26**	**401**	**553**	**2,702**
PUBLIC INVESTMENT	**380**	**380**	**380**	**3,156**
TOTAL INVESTMENT	**406**	**781**	**933**	**5,858**

NPV = net present value; SB = Senate Bill; CHP = combined heat and power; IGCC = integrated gasification combined cycle; PBF = Public Benefits Fund; CO_2 = carbon dioxide.

APPENDIX A: DERIVATION OF ECONOMIC MULTIPLIERS AND PREDICTIVE MODEL

In input-output analysis, the derivation of economic multipliers begins with a transactions table. The transaction table is an accounting of the value of inter-industry exchanges in an economy within a fixed period of time, typically a year. The table below (Figure 0-1) is an example of a hypothetical three sector economy.

Figure 0-1: Transactions Table[a]

	A	B	C	Final Demand	Total Output
A	.06	.06	.44	9.44	10
B	.25	.75	0	29	30
C	1.4	2.07	1.56	34.97	40
Value Added	6.5	24	30		
Total Inputs	10	30	40		

[a]Source: (Minnesota IMPLAN Group, Inc. 2004)

The rows in the transaction table represent the direct sale of outputs from a given sector to other sectors in the economy, while the columns in the table represent the purchase of inputs by a given sector from other sectors needed to produce its outputs. Direct sales of finished goods to consumers and exports are recorded as entries in the final demand column. Employee compensation, stockholder dividends, and tax payments are recorded as entries in the Value-Added row. A sector's total inputs equal its total output, hence input-output (Schaffer 1999).

This relationship can be expressed algebraically as:

$$X_i = \sum_{j=1}^{n} x_{ij} + Y_i \qquad (1)$$

Where

n...number of sectors

i...row vector

j...column vector

X_i= total input/output of sector i

x_{ij} = output of sector i sold to sector j

Y_i = output of sector i sold to final demand

The values in a transactions table and its derivatives typically come from government or private sector data sources. The NCESEIM utilizes state-level data from 2004 compiled by the Minnesota IMPLAN

Group, which in turn is derived from a number of federal and state agency sources, including as the U.S. Department of Commerce's Bureau of Economic Analysis *Benchmark Input-Output Accounts*.

Dividing each column entry in the transaction table by the sum of all the entries in the column reveals a production recipe describing where an industry purchases inputs and in what proportions for each dollar of its total output. The resulting matrix of values is known as the direct requirements coefficient table, or A Matrix (Figure 0-2).

Figure 0-2: A Matrix[a]

	A	B	C
A	.006	.002	.011
B	.025	.025	0
C	.14	.069	.039
Value Added	6.5	.8	.75
Industry Output	1	1	1

[a]Source: (Minnesota IMPLAN Group, Inc. 2004)

While the NCESEIM bypasses the calculation of the direct requirements coefficients, extracting them directly from the North Carolina IMPLAN data set, the algebra underlying the values is important in deriving multipliers that represent both the direct and interindustry effects.

Therefore let,

$$a_{ij} = \frac{x_{ij}}{X_i} \qquad (2)$$

Where,

$$a_{ij} = \text{direct requirements coefficient } 0 \le a_{ij} \le 1$$
$$x_{ij} = \text{ output of industry } i \text{ sold to sector } j$$
$$X_i = \text{total input/output of sector } i$$

This relationship can also be written as $x_{ij} = a_{ij} X_i$ and substituted in the total output equation as:

$$X_i = \sum_{j=1}^{n} a_{ij} X_i + Y_i \qquad (3)$$

Or expressed in matrix notation as:

$$X = A \cdot X + Y \qquad (4)$$

Where,

$$A = \text{the A Matrix } (a_{ij \to n})$$
$$X = \text{total sector outputs } (X_{i \to n})$$
$$Y = \text{final demands } (Y_{j \to n})$$

Solving for Y results in:

$$Y = X - A \cdot X \qquad (5)$$

X is then isolated by factoring to get:

$$Y = (I - A) \cdot X \qquad (6)$$

Where I is the identity matrix, the matrix algebra equivalent of 1.

To solve for X, both sides of the equation are multiplied by the inverse of $I - A$ or $(I - A)^{-1}$ resulting in:

$$(I - A)^{-1} \cdot Y = (I - A)^{-1} \cdot (I - A) \cdot X \qquad (7)$$

Simplified as:

$$X = (I - A)^{-1} \cdot Y \qquad (8)$$

And interpreted as changes in total industry output (X) equal changes in final demand multiplied by $(I - A)^{-1}$ or

$$\Delta X = (I - A)^{-1} \cdot \Delta Y \qquad (9)$$

Consequently, $(I - A)^{-1}$ is the table of total requirements coefficients or the Leontief inverse (Figure 0-3). The coefficients represent the total purchase of outputs for a given sector from another sector for each dollar of output to meet that sector's final demand. In other words, the coefficients capture both the direct and indirect effects. When households are included in the matrix of industry sectors, the matrix yields the direct, indirect, and induced multiplier effects, or Type II multiplier (Schaffer 1999). To calculate the Type II multiplier, the NCESEIM divides household consumption by total labor income in the region to create household consumption coefficients.

Figure 0-3: Table of Total Requirements Coefficients[a]

	A	B	C
A	1.008	.003	.011
B	.026	1.026	0
C	.148	.074	1.042
Total Activity	1.182	1.103	1.054

[a] Source: (Minnesota IMPLAN Group, Inc. 2004)

From the table of total requirements it is possible to derive multipliers for employment, employee compensation, and gross state product that predict the consequences of changes in final demand. According to the logic of input-output analysis, a change in sectoral final demand will result in a change in sectoral total output. Likewise, input-output analysis assumes a linear relationship between changes in final demand and employment, employee compensation, and gross state product (Schaffer 1999).

Employment multipliers measure the relationship between the value of the output of a sector and employment in that sector. The direct effect is calculated by dividing total sector employment by total sector output, or:

$$w_i = \frac{W_i}{X_i} \qquad (10)$$

Where,

$w_i =$ direct employment ratio
$W_i =$ total sector employement
$X_i =$ total sector output

To calculate the total employment multiplier effect, the direct employment ratio is multiplied by the corresponding column vector in the $(I - A)^{-1}$ matrix, or:

$$M_{employment,j} = \sum_{i=1}^{n} w_i \alpha_{ij} \qquad (11)$$

Where,

$\alpha_{ij} =$ Leontief inverse matrix
$M_{employment,j} =$ total employment requirements

The multipliers for income and gross state product can be derived in a likewise fashion (Schaffer 1999). Income multipliers measure the impact of changes to final demand on income received by households (both employee and proprietor compensation) and show the direct, indirect, and induced effects of a dollar's worth of output in terms of a dollar's worth of new household income. The equation is expressed as:

$$M_{income,j} = \sum_{i=1}^{n} a_i \alpha_{ij} \qquad (12)$$

Where,

$a_i =$ sector i income per dollar of output

$\alpha_{ij} =$ Leontief inverse matrix

$\mathrm{M}_{income,j} =$ total income requirements

Gross state product multipliers measure the impact of changes to final demand on incomes earned by labor and capital and show the direct, indirect, and induced effects of a dollar's worth of output in terms of a dollar's worth of final demand delivieries by sector *j*. The equation is expressed as:

$$M_{GSP,j} = \sum_{i=1}^{n} a_i \alpha_{ij} \qquad (13)$$

Where,

$a_i =$ sector i GSP per dollar of output

$\alpha_{ij} =$ Leontief inverse matrix

$\mathrm{M}_{GSP,j} =$ total GSP requirements

Thus, the total number of jobs, income, and gross state product created per dollar of new final demand for a given sector thus can then be expressed as:

$$\Delta Z = \Delta Y \cdot M_Z \qquad (14)$$

Where,

$M_z =$ the direct requirements matrix for employment, income, or GSP $(\mathrm{M}_{ij \to n})$

$\Delta Z =$ change in total sector employment, income, or GSP $(Z_{i \to n})$

$\Delta Y =$ change in final demand $(Y_{j \to n})$

APPENDIX B: METHODOLOGY

ES-1, ES-2 & AFW-5: RENEWABLE ENERGY PRODUCTION SUBSIDY, RENEWABLE PORTFOLIO STANDARD, & BIOMASS PRODUCTION SUBSIDY

The cost to ratepayers, private investments, and public subsidies resulting from the implementation of these mitigation options was based on the technical assumptions of the ES and AFW technical working groups. The cost to ratepayers for ES-1 was calculated by multiplying the "rate impact" by the "total sales after mitigation option." The cost to ratepayer for ES-2 was calculated by taking the difference in total sales between the reference case and mitigation case scenarios and multiplying by the "rate impact"*. Since the ES technical working group did not break down sales by customer class, the ASU Energy Center utilized the RCI technical working group's sales forecast by customer class to determine the proportion of these costs borne by a given customer class. The distribution of these costs to a given economic sector was based on that sector's Energy Consumption Coefficient and treated as a decrease in final demand.

Due to the reduction in electricity sales from energy efficiency component of ES-2 by the end of the study period, customers realize a net savings. Moreover, the value of avoided fuel costs, resulting from the displacement of conventional generation, is assumed to be passed along to customers as an adjustment to utility fuel cost adjustment riders. These savings are treated as an increase in final demand while the resulting reduction in revenue for utility sectors is treated as a reduction in final demand for those sectors. Significantly, it was assumed that only a portion of the monetary value of energy savings would impact the North Carolina economy, as industries and consumers import a percentage of goods and services from outside the state.

The energy efficiency component of ES-2 is expected to cause energy customers to incur costs beyond the ratepayer impact, as customers make outlays for their share of efficiency measures. To calculate the annual value of these participant measure costs, the ASU Energy Center multiplied physical energy savings by customer class by the first-year participant cost by customer class. First-year participant costs were derived by computing the present value of the levelized cost of the participant's share of the efficiency measure, as reported by the RCI technical working group, assuming a 5% discount rate and a term of ten years for each customer class. These costs were then allocated as reductions in final demand according to a sector's Energy Consumption Coefficient. Energy efficiency investments were allocated as increase in final demand according to the methodology described for RCI-1, RCI-2 & RCI-11.

The value of private investment associated with implementation of renewable energy components of ES-1 and ES-2 consists of annual capital investments and operating expenses, including the value of feedstocks to fuel biomass systems. Annual capital investments by technology type were calculated by

* See (GDS Associates 2006) which suggests cost sharing approach where the utility pays for a portion of an efficiency measure to induce participation by a customer, as in a rebate program. Therefore, the REPS sensitivity assumes the rate impact associated with energy efficiency component of mitigation option only includes the utility's share of the efficiency measure and overhead, as reported in (Center for Climate Strategies 2007b).

multiplying incremental renewable generation by technology type by the calculated capital investment cost by technology type. The calculated capital investment costs were computed by decomposing the ES technical working group's "Levelized Renewable Technology Costs," based on the annualization factors cited by the ES technical working group. Annual fuel costs and operating expenses by technology type were calculated in a similar fashion.

The value of public subsidies was taken directly from the ES technical working group analysis. It was assumed these subsidies would come from existing state revenues and therefore would result in a reduction in state government expenditures to each economic sector, and in final demand, according to a sector's Government Spending Coefficient.

Conservatively, it was assumed that only the labor portion of the capital investments and operating expenses associated with private investments in renewable energy generation would impact the North Carolina economy. The labor share of capital investments increases final demand for Heavy Construction while the labor share of operating expenses increases final demand for the Electric Utility sectors. The value of feedstocks to supply biomass facilities increases final demand for the Forestry sector. It was also assumed that a portion of the financing costs associated with investments would benefit the Financial, Insurance, and Real Estate sector. Finally, the displacement of new conventional electricity generation is reflected as a reduction in Final Demand for the Heavy Construction and Electric Utility sectors.

The table below summarizes the key variables and assumptions used to derive the net annual changes in final demand resulting from implementation of the mitigation option.

Variable/Assumption	Value
Rate Impact, ES-1 ($/MWh)[a]	$0.0143 (in 2020)
Rate Impact, ES-2 ($/MWh)[a]	$0.628 (in 2020)
First-year Participant Measure Cost, Residential[b]	$105.79
First-year Participant Measure Cost, Commercial[c]	$156.72
First-year Participant Measure Cost, Industrial[d]	$70.52
Decomposed Capital Cost, Hydroelectric ($/MWh-first year)[e]	$879.79
Decomposed Capital Cost, Wind ($/MWh-first year)[e]	$602.57
Decomposed Capital Cost, Hog Waste ($/MWh-first year)[e]	$346.32
Decomposed Capital Cost, Poultry Litter ($/MWh)[e]	$550.80
Decomposed Capital Cost, Biomass Co-firing($/MWh-first year)[e]	$52.32
Decomposed Capital Cost, Dedicated Biomass ($/MWh-first year)[e]	$424.58
Decomposed Operating Cost, Hydroelectric ($/MWh)[e]	$4.89
Decomposed Operating Cost, Wind ($/MWh)[e]	$13.31
Decomposed Operating Cost, Hog Waste ($/MWh)[e]	$41.50
Decomposed Operating Cost, Poultry Litter ($/MWh)[e]	$22.69
Decomposed Operating Cost, Biomass Co-firing ($/MWh)[e]	$1.95
Decomposed Operating Cost, Dedicated Biomass($/MWh)[e]	$15.80
Decomposed Fuel Cost, Biomass Co-firing ($/MWh)[e]	$4.45 (in 2007), $4.57 (in 2020)
Decomposed Operating Cost, Dedicated Biomass($/MWh)[e]	$36.10 (in 2007), $37.11(in 2020)

Share of Renewable Generation, Hydroelectric[f]	11%
Share of Renewable Generation, Hydroelectric [f]	11%
Share of Renewable Generation, Wind [f]	25%
Share of Renewable Generation, Hog Waste [f]	4%
Share of Renewable Generation, Poultry Litter [f]	5%
Share of Renewable Generation, Biomass Co-firing [f]	16%
Share of Renewable Generation, Dedicated Biomass [f]	39%
Share of Renewable Capital Investments to Heavy Construction[g]	10%
Share of Renewable Operating Expenses to Electric Utilities [g]	26%
Share of Renewable Fuel & Feedstock to Forestry [g]	90%
Share of Total Energy Efficiency Investments to Residential Construction[h]	26.8%
Share of Total Energy Efficiency Investments to Commercial Construction[i]	32.2%
Share of Total Energy Efficiency Investments to Wholesale Trade [i]	8.6%
Share of Total Energy Efficiency Investments to Retail Trade [h]	15.5%
Share of Total Energy Efficiency Investments to Professional, Scientific, Technical & Management Services [i]	4.3%
Share of Total Energy Efficiency Investments to Other Services [i]	8.6%
Financing Assumptions, Residential [j] Interest rate Fraction financed Term Fraction Local Borrowing	 8% 75% 5 years 64.2%
Financing Assumptions, Commercial [j] Interest rate Fraction financed Term Fraction Local Borrowing	 8% 75% 5 years 64.2%
Financing Assumptions, Industrial [j] Interest rate Fraction financed Term Fraction Local Borrowing	 8% 75% 10 years 64.2%
Financing Assumptions, Renewables [j] Interest rate Fraction financed Term Fraction Local Borrowing	 8% 50% 15 years 64.2%

[a] Source: (Center for Climate Strategies 2007a).
[b] Calculation based on levelized cost of $13.70/MWh cited in (Center for Climate Strategies 2007c).
[c] Calculation based on levelized cost of $20.30/MWh cited in (Center for Climate Strategies 2007c).
[d] Calculation based on levelized cost of $9.13/MWh cited in (Center for Climate Strategies 2007c).
[e] Source: Calculation based on levelized costs & annualization factors cited in (Center for Climate Strategies 2007b).
[f] Source: (Center for Climate Strategies 2007b).
[g] Source: (LaCapra Associates 2006).
[h] Source:(GDS Associates 2006). Weighted for distribution of spending among customer classes.
[i] Source: (Sedano 2005).Weighted for distribution of spending among customer classes.
[j] Assumption. Local borrowing based on regional purchase coefficient for Financial, Insurance, and real estate sector in (Minnesota IMPLAN Group 2005).

ES-3 & ES-9: Combined Heat and Power

The value of energy savings and private investments, including annual capital costs and operating expenses, resulting from the implementation of this mitigation option were based on the technical assumptions of the ES and RCI technical working group. Annual capital investments by technology type were calculated by multiplying incremental CHP generation by technology type by its calculated capital investment cost. Calculated capital investment costs were computed by decomposing the RCI technical working group's "Estimated Average Installed Capital Costs by System Type," based on the annualization factors cited by the RCI technical working group. Annual fuel costs and operating expenses by technology type were calculated in a similar fashion, except they were calculated using cumulative CHP generation. These investment costs were distributed to the commercial and industrial customer classes and, in turn, to a given economic sector based on its Energy Consumption coefficient*.

CHP systems utilize the thermal energy produced when generating electricity in applications such as space heating, cooling, and dehumidification; displacing the consumption of other fuels normally used to power these applications. The ES technical working group calculated these energy savings by fuel type and the ASU Energy Center distributed them to the commercial and industrial customer classes. The monetary value of these savings was then calculated by multiplying energy savings by fuel type by the ES technical working groups "Industrial Sector Energy Costs in the South Atlantic Region" forecast†. These energy savings were then allocated to a given economic sector based on its Energy Consumption coefficient. Conversely, the resulting reduction in revenue for energy utilities results in a reduction in final demand for those sectors, while reduced consumption of other fuels decrease final demand for the Forestry (biomass), Retail Trade (fuel oil), and Wholesale Trade (coal) sectors.

Conservatively, it was assumed that only the labor portion of the capital investments and operating expenses associated with private investments in CHP generation would impact the North Carolina economy. The labor shares of capital investments increase final demand for Heavy Construction while the labor shares of operating expenses increase final demand for the Electric Utility sectors. The value of fuels and feedstocks to supply CHP facilities increases final demand for the Natural Gas, Wholesale Trade (coal), Retail Trade (fuel oil) and Forestry (biomass) sectors. It was also assumed that a portion of the financing costs associated with investments would benefit the Financial, Insurance, and Real Estate sector. Finally, the displacement of new conventional electricity generation is reflected as a reduction in Final Demand for the Heavy Construction and Electric Utility sectors.

The table below summarizes the key variables and assumptions used to derive the net annual changes in final demand resulting from implementation of the mitigation option.

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* It was assumed two-thirds of the CHP systems would be installed by commercial customers and one third by industrial customers, per email correspondence with RCI technical working group facilitator David Von Hippel.

† Natural Gas and Electricity savings were multiplied by the RCI technical working group's retail electricity price forecast (Center for Climate Strategies 2007c).

Variable/Assumption	Value
Decomposed CHP Capital Cost, Natural Gas ($/MWh-first year)[a]	$309.30 (in 2007), $226.82 (in 2020)
Decomposed CHP Capital Cost, Biomass ($/MWh-first year)[a]	$494.88 (in 2007), $412.40 (in 2020)
Decomposed CHP Capital Cost, Coal ($/MWh-first year)[a]	$453.64 (in 2007), $412.40 (in 2020)
Decomposed CHP Operating Expense, Natural Gas ($/MWh)[a]	$10.00
Decomposed CHP Operating Expense, Biomass ($/MWh)[a]	$25.00
Decomposed CHP Operating Expense, Coal ($/MWh)[a]	$20.00
Labor Share of CHP Capital Investment, Natural Gas[b]	23%
Labor Share of CHP Capital Investment, Biomass[b]	50%
Labor Share of CHP Capital Investment, Coal[b]	50%
Labor Share of CHP Operating Expenses, Natural Gas[b]	45.0%
Labor Share of CHP Operating Expenses, Biomass[b]	13.0%
Labor Share of CHP Operating Expenses, Coal[b]	39.0%
Share of Biomass Feedstock to Forestry[b]	90%

[a] Source: Calculation based on levelized costs & annualization factors cited in (Center for Climate Strategies 2007c).
[b] Source: (LaCapra Associates 2006). Assumes CHP from natural gas is equivalent to "combustion turbine." Assumes CHP from biomass is equivalent to "dedicated biomass combustion." Assumes CHP from coal is equivalent to "pulverized coal."

ES-6A & ES-6B: ADVANCED COAL TECHNOLOGIES

The cost to ratepayers, private investments, and public subsidies resulting from the implementation of these mitigation options was based on the technical assumptions of the ES technical working group. The cost to ratepayers for both ES-6a and ES-6b was calculated by multiplying the ES technical working group's "Rate Impact" by the "Total Sales after Mitigation Option." Since the ES technical working group did not provide sales by customer class, the ASU Energy Center utilized the RCI technical working group's sales forecast by customer class to determine the proportion of these costs borne by a given customer class. The distribution of these costs to a given economic sector was based on that sector's Energy Consumption Coefficient and treated as a decrease in final demand.

The value of private investment associated with implementation of ES-6a and ES-6b consists of annual capital investments and operating expenses. Net annual capital investments were calculated by multiplying the difference in incremental generation by technology type by the calculated capital investment cost by technology type. Calculated capital investment costs for conventional generation was computed by decomposing the ES technical working group's "Levelized New Fossil Technology Costs," based on the annualization factors cited by the ES technical working group. Net annual fuel costs and net annual operating expenses by technology type were calculated in a similar fashion, except they were calculated using the difference in cumulative generation by technology type.

Conservatively, it was assumed that only the labor portion of the net capital investments and net operating expenses associated with the mitigation option would impact the North Carolina economy. The labor shares of net capital investments increase final demand for Heavy Construction while the labor shares of net operating expenses increase final demand for the Electric Utility sectors. It was also assumed that a portion of the financing costs associated with investments would benefit the local Financial, Insurance, and Real Estate sector.

The table below summarizes the key variables and assumptions used to derive the net annual changes in final demand resulting from implementation of the mitigation option.

Variable/Assumption	Value
Decomposed Capital Cost, IGCC ($/MWh-first year)[a]	$241.84
Decomposed Capital Cost, Conventional Coal ($/MWh-first year)[a]	$206.23
Decomposed Operating Cost, IGCC ($/MWh)[a]	$7.92
Decomposed Operating Cost, Conventional Coal ($/MWh)[a]	$7.51
Labor Share of IGCC Capital Investment[b]	23%
Labor Share of Conventional Coal Capital Investment[b]	30%
Labor Share of IGCC Operating Expenses[b]	45%
Labor Share of Conventional Coal Operating Expenses[b]	39%
Financing Assumptions, Advanced Coal[c] Interest rate Fraction financed Term Fraction Local Borrowing	 8% 50% 25 years 64.2%

[a] Source: Calculation based on levelized costs & annualization factors cited in (Center for Climate Strategies 2007b).
[b] Source:(LaCapra Associates 2006). Assumes IGCC is equivalent to "Combined Cycle."
[c] Assumption. Local borrowing based on regional purchase coefficient for Financial, Insurance, and real estate sector in (Minnesota IMPLAN Group 2005).

ES-8: Municipal Biogas

Utilizing the technology cost and performance assumptions developed by the ES technical working group, the Energy Center calculated the cost of subsidy payments and annual capital investments and operating costs required to meet the implementation schedule articulated in the mitigation option description. Annual capital investments were calculated by multiplying incremental generation by the calculated capital investment cost. The calculated capital investments cost was computed by decomposing the ES technical working group's "Levelized Renewable Technology Costs," based on the annualization factors cited by the ES technical working group. Annual operating expenses were calculated in a similar fashion, except they were multiplied by cumulative generation.

Conservatively, it was assumed that only the labor portion of the capital investments and operating expenses associated with the mitigation option would impact the North Carolina economy. The labor share of capital investments increases final demand for Heavy Construction while the labor share of operating expenses increases final demand for Electric Utilities. Further, the displacement of new conventional electricity generation is reflected as a reduction in Final Demand for the Heavy Construction and Electric Utility sectors.

The value of electricity generated by the mitigation option was calculated by multiplying cumulative generation by the RCI technical working group's levelized electricity price forecast for the commercial sector. It was assumed that the value of electricity generated by the mitigation option would accrue to the Water & Sewer sector as an increase in final demand. The cost of subsidy payments was assumed to be the sum of annual capital and operating expenses. It was assumed that the subsidy payments come from existing state revenues and therefore will result in corresponding reduction in other state government expenditures, excluding education. Moreover, the value of avoided fuel costs, resulting from the displacement of conventional generation, is assumed to be passed along to customers as an adjustment to utility fuel cost adjustment riders.

The table below summarizes the key variables and assumptions used to derive the net annual changes in final demand resulting from implementation of the mitigation option.

Variable/Assumption	Value
Decomposed Capital Cost, Biogas ($/MWh-first year)[a]	$259.76
Decomposed Operating Cost, Biogas ($/MWh)[a]	$10.25
Labor Share of Biogas Capital Investment[b]	30%
Labor Share of Biogas Operating Expenses[b]	30%

[a] Source: Calculation based on levelized costs & annualization factors cited in (Center for Climate Strategies 2007b).
[b] Source:(LaCapra Associates 2006). Assumes municipal biogas equivalent to "hog waste."

RCI-1, RCI-2 & RCI-11: Energy Efficiency Funding & Energy Audits

Utilizing the values developed by the RCI technical working group for RCI-1 and RCI-2, the ASU Energy Center calculated program costs by customer class. These program costs include the program administrator's share of an efficiency measure and their overhead expenses. In its analysis, the RCI technical working group only calculated the aggregate program costs associated with a given mitigation option. So in order to estimate the impact of these costs on a particular customer class, the ASU Energy Center simply distributed the program costs in proportion to customer class' share of reference case sales.

The program costs, the program administrator's share of the efficiency measures and their overhead expenses, by customer class for RCI-11 were calculated by multiplying the class' physical energy savings achieved by the measure by its "Levelized Cost of Electricity Savings from Technical Assistance Recommendations," as determined by the RCI technical working group. The distribution of these program costs to a given economic sector was based on that sector's Energy Consumption Coefficient and treated as a decrease in final demand.

An analogous approach was used to determine the distribution of energy savings by customer class and economic sector for RCI-1 and RCI-2. The RCI technical working group's stated cumulative physical energy savings were divided among each customer class in proportion to its share of reference case sales. In turn, these physical energy savings by customer class were multiplied by the RCI technical working group's retail price forecast to yield a monetary value of avoided energy consumption. These values were then allocated to each economic sector according to its Energy Consumption Coefficient and treated as an increase in final demand while the resulting reduction in revenue for utility sectors is treated as a reduction in final demand for those sectors. Significantly it was assumed that only a portion of the monetary value of energy savings would impact the North Carolina economy, as industries and consumers import a percentage of goods and services from outside the state.

Notably, RCI-1, RCI-2, and RCI-11 are expected to cause energy customers to incur additional costs beyond the program costs, as customers make outlays for their share of efficiency measures*. To calculate the annual value of these participant measure costs, the ASU Energy Center calculated the present value of the RCI technical working group's stated "Levelized Cost per Megawatt-hour for Participant Measure" assuming a 5% discount rate and a term of ten years for each customer class. The resulting first-year participant cost per megawatt-hour was in turn multiplied by physical energy savings by customer class and then allocated as reductions in final demand according to a sector's Energy Consumption Coefficient.

While both the program costs and participant measure costs are negative stimuli, the resulting investments in efficiency measures are positive stimuli to the North Carolina economy. In modeling the

* See (LaCapra Associates 2006). Report suggests cost sharing approach where the utility pays for a portion of an efficiency measure to induce participation by a customer, as in a rebate program.

distribution of these investments across the economy the ASU Energy Center relied on additional research. This approach to allocating energy efficiency investments is utilized in the analysis of several other RCI options.

The distribution of residential energy efficiency investments were based on a study of the cost effectiveness of various efficiency measures conducted for the North Carolina Utilities Commission (GDS Associates 2006). Depending on the characteristics of each residential measure, a portion of the investment was then allocated to either the Residential Construction or Retail Trade sector. For example, lighting and appliance measures were allocated entirely to Retail Trade while weatherization measures were allocated to Residential Construction.

The distribution of commercial and industrial efficiency measures were based on an economic impact study of similar energy efficiency programs (Sedano 2005). Modeling assumes commercial and industrial efficiency spending will parallel the report's "Allocation of Efficiency Program Outlays" and that this spending will be split equally among "new construction" and "retrofit/products and services" measures. Further, the modeling follows the report's allocation to final demand scheme.

Additionally, it was assumed these programs would be administered by the utilities and that a share of the program costs would accrue to these sectors. It was also assumed that a portion of the financing costs associated with investments would benefit the local Financial, Insurance, and Real Estate sector. Finally, the displacement of new conventional electricity generation is reflected as a reduction in Final Demand for the Heavy Construction and Electric Utility sectors.

The table below summarizes the key variables and assumptions used to derive the net annual changes in final demand resulting from implementation of the mitigation option.

Variable/Assumption	**Value**
First-year Participant Measure Cost, Residential ($/MWh)[a]	$105.79
First-year Participant Measure Cost, Commercial ($/MWh)[b]	$156.72
First-year Participant Measure Cost, Industrial ($/MWh)[c]	$70.52
First-year Participant Measure Cost, All Sector ($/MMBtu)[d]	$5.95
Share of Program Administrator Costs for Administration & Education[e]	16%
Share of Program Administrator Costs for Measures [d]	84%
Share of Total Energy Efficiency Investments to Residential Construction[f]	25.5%
Share of Total Energy Efficiency Investments to Commercial Construction[g]	37.4%
Share of Total Energy Efficiency Investments to Wholesale Trade [f]	8.9%
Share of Total Energy Efficiency Investments to Retail Trade [e]	14.7%
Share of Total Energy Efficiency Investments to Professional, Scientific, Technical & Management Services [f]	4.5%
Share of Total Energy Efficiency Investments to Other Services [f]	8.9%
Financing Assumptions, Residential [h] Interest rate Fraction financed Term Fraction Local Borrowing	 8% 85% 10 years 64.2%

Financing Assumptions, Commercial [g]	
Interest rate	8%
Fraction financed	85%
Term	15 years
Fraction Local Borrowing	64.2%
Financing Assumptions, Industrial [g]	
Interest rate	8%
Fraction financed	85%
Term	15 years
Fraction Local Borrowing	64.2%

[a] Calculation based on levelized cost of $13.70/MWh cited in(Center for Climate Strategies 2007c).
[b] Calculation based on levelized cost of $20.30/MWh cited in (Center for Climate Strategies 2007c).
[c] Calculation based on levelized cost of $9.13/MWh cited in (Center for Climate Strategies 2007c).
[d] Calculation based on levelized cost of $9.13/MWh cited in (Center for Climate Strategies 2007c).
[e] Calculation based on Program Administrator costs cited (Center for Climate Strategies 2007c).
[f] Source: (GDS Associates 2006). Weighted for distribution of spending among customer classes.
[g] Source: (Sedano 2005). Weighted for distribution of spending among customer classes.
[h] Assumption. Local borrowing based on regional purchase coefficient for Financial, Insurance, and real estate sector in (Minnesota IMPLAN Group 2005).

RCI-4 & RCI-5: Market Transformation & Appliance Standards

Utilizing the technical assumptions developed by the RCI technical working group for RCI-4, the ASU Energy Center calculated program administrator and participant costs by customer class. In its analysis, the RCI technical working group first determined the total physical energy savings achieved by the program. The ASU Energy Center distributed these energy savings in proportion to each customer class' share of reference case sales with extra weight given to the residential and commercial sectors*. To calculate program administrator and participant costs, the distribution of physical energy savings by customer class was multiplying by the assumed program administrator's and participant's share of the RCI's "Cost of Market Transformation Program Savings." The distribution of these program costs to a given economic sector was based on that sector's Energy Consumption Coefficient and reflected as a reduction in final demand. Investments in energy efficiency measures resulting from the implementation of RCI-4 were allocated across the economy according to the approach described for RCI-1, RCI-2 & RCI-11.

The distribution of physical energy savings referenced above was also used to calculate the monetary value of energy savings realized by the mitigation option. These physical energy savings by customer class were multiplied by the RCI technical working group's retail price forecast to yield a monetary value of avoided energy consumption. These values were then allocated to each economic sector according to its Energy Consumption Coefficient and treated as an increase in final demand while the resulting reduction in revenue for utility sectors is treated as a reduction in final demand for those sectors. Significantly, it was assumed that only a portion of the monetary value of energy savings would impact the North Carolina economy, as industries and consumers import a percentage of goods and services from outside the state.

The RCI technical working group analysis did not present annual participant costs or savings for RCI-5, but rather adjusted the stated cost effectiveness through 2030 cited in the joint Appliance Standards Awareness Project/American Council for an Energy Efficient Economy (ASAP/ACEEE) report (Nadel, deLaski et al. 2006) to the 2007-2020 study period of the CAPAG analysis. Therefore, the ASU Energy Center replicated the ASAP/ACEEE methodology to determine annual costs and savings by customer class.

* Per email correspondence with the RCI technical working group facilitator David Von Hippel, the ASU Energy Center applied weighting factors of 1, 1, and .25 respectively to the reference case sales projection for residential, commercial, and industrial customer classes.

The table below summarizes the key variables used in the replication.

	Sector[a]	Annual Savings per Unit (kWh/ [MMBtu])[b]	Incremental Cost per Unit ($)[b]	Annual Energy Savings from 1 yr of Sales (GWh/ [MMBTU])[b]	Product lifetime [b]	Calculated Annual Unit Sales[c]
ELECTRIC MEASURES						
Bottle-type water dispensers	Commercial	266	12	0.9	8	3,383
Commercial hot food cabinets	Commercial	1815	453	0.9	15	496
Liquid-immersed distribution transformers	Commercial	6	2	18.5	30	3,083,333
Dry distribution transformers	Commercial	4.5	1.6	1.1	30	21,256
Metal halide lamp fixtures	Commercial	307	30	20.6	20	67,101
Incandescent reflector lamps	Commercial	61	1	175.5	0.94	2,877,049
Walk-in refrigerators & freezers	Commercial	8200	957	10	12	1,220
Electric spas & hot tubs	Residential	250	100	0.3	10	1,200
Residential furnaces & boilers (electric)	Residential	585	100	34.6	18	59,145
External AC/DC power supplies	Residential	4	0.5	19.8	7	4,950,000
Compact audio products	Residential	53	1	9.8	5	184,906
DVD players & recorders	Residential	11	1	1.4	5	127,273
Natural Gas Measures						
Commercial boilers	Commercial	15.9	2968	13,815.40	30	869
Residential furnaces & boilers (gas)	Residential	0.8	6	3396.114	18	4,245
Pool heaters	Residential	5.8	295	26806	15	4,622

[a] Assumption.
[b] Source:(Nadel, deLaski et al. 2006).
[c] Calculation.

First, the ASU Energy Center categorized the ASAP/ACEEE's efficiency standards as either a commercial or residential standard based on a content analysis of the measure's description. Next, annual participant costs by customer class were calculated by summing the products of each measure's incremental cost per unit by the calculated number of annual unit sales. The calculated number of annual unit sales was computed by dividing each measure's "annual energy savings from one year's sales" by the "annual savings per unit." As with the ASAP/ACEEE methodology, it was assumed that annual unit sales remained constant over the study period. The distribution of these program costs to a given economic sector was based on that sector's Energy Consumption Coefficient and treated as a decrease in final demand.

The cumulative physical energy savings in a given year for a given measure was, in most instances, computed by multiplying annual unit sales by per unit energy savings by the number of years from the mitigation option implementation minus half a year. In instances where the expected lifetime of the measure was less than the number of years from mitigation option implementation, physical energy savings in a given year were calculated by multiplying annual unit sales by the expected product lifetime by per unit energy savings. This avoids double counting of savings after full market penetration. These physical energy savings were then summed by customer class and multiplied by the RCI technical working group's retail price forecast to determine the monetary value of avoided energy consumption. In turn, a portion of these monetary savings were allocated to each economic sector according to its Energy Consumption Coefficient and treated as an increase in final demand. Reductions in revenue to utility sectors were treated as a reduction in final demand for those sectors.

For both RCI-4 and RCI-5, it was also assumed that a portion of the financing costs associated with investments would benefit the local Financial, Insurance, and Real Estate sector. Finally, the displacement of new conventional electricity generation is reflected as a reduction in Final Demand for the Heavy Construction and Electric Utility sectors.

The table below summarizes the key variables and assumptions used to derive the net annual changes in final demand resulting from implementation of the mitigation option.

Variable/Assumption	**Value**
RCI-4 Participant Measure Cost, all sectors($/MWh)[a]	$46.33
RCI-4 Program Administrator Cost, all sectors($/MWh)[a]	$6
Financing Assumptions, Residential[b]	
Interest rate	8%
Fraction financed	85%
Term	10 years
Fraction Local Borrowing	64.2%
Financing Assumptions, Commercial[b]	
Interest rate	8%
Fraction financed	85%
Term	15 years
Fraction Local Borrowing	64.2%
Financing Assumptions, Industrial[b]	
Interest rate	8%
Fraction financed	85%
Term	15 years
Fraction Local Borrowing	64.2%

[a] Calculation based on levelized cost of $6.00/MWh cited in(Center for Climate Strategies 2007c).
[b] Assumption. Local borrowing based on regional purchase coefficient for Financial, Insurance, and real estate sector in (Minnesota IMPLAN Group 2005).

RCI 6: Building Codes

Utilizing the values developed by the RCI technical working group the ASU Energy Center calculated annual program costs and savings by customer class. To calculate the annual value of the program costs, the ASU Energy Center calculated the present value of the RCI technical working group's stated "Levelized Cost of Electricity Savings" assuming a 5% discount rate and a term of twenty-five years. The resulting first-year participant cost per megawatt-hour was in turn multiplied by physical energy savings by customer class, as determined by the RCI technical working group, and then allocated as reductions in final demand according to a sector's Energy Consumption Coefficient. Investments in energy efficiency measures resulting from the implementation of RCI 6 were allocated to the Residential and Commercial Construction sectors.

As with other energy saving options examined in this study, the value of the physical energy savings achieved by the mitigation option were calculated by multiplying physical energy savings by customer class by the RCI technical working group's retail price forecast. Again, these values were allocated to each economic sector according to its Energy Consumption Coefficient and treated as an increase in final demand. The resulting reduction in revenue for utility sectors was treated as a reduction in final demand for those sectors. Significantly it was assumed that only a portion of the monetary value of energy savings would impact the North Carolina economy, as industries and consumers import a percentage of goods and services from outside the state.

Finally it was assumed that a portion of the financing costs associated with investments would benefit the local Financial, Insurance, and Real Estate sector and that the displacement of new conventional electricity generation results in a reduction in Final Demand for the Heavy Construction and Electric Utility sectors.

The table below summarizes the key variables and assumptions used to derive the net annual changes in final demand resulting from implementation of the mitigation option.

Variable/Assumption	Value
First-year Participant Measure Cost, Electric[a]	$492.79
First-year Participant Measure Cost, Natural Gas [a]	$71.23
Financing Assumptions, Residential [b]	
Interest rate	8%
Fraction financed	80%
Term	25 years
Fraction Local Borrowing	64.2%
Financing Assumptions, Commercial [b]	
Interest rate	8%
Fraction financed	80%
Term	25 years
Fraction Local Borrowing	64.2%
Financing Assumptions, Industrial [b]	
Interest rate	8%
Fraction financed	80%
Term	25 years
Fraction Local Borrowing	64.2%

[a] Calculation based on levelized cost of $34.97/MWh (electric) and $5.05/MMBtu (natural gas) cited in (Center for Climate Strategies 2007c).
[b] Assumption. Local borrowing based on regional purchase coefficient for Financial, Insurance, and real estate sector in (Minnesota IMPLAN Group 2005).

RCI-7 & RCI-3: High Performance Buildings

Utilizing the values developed by the RCI technical working group the ASU Energy Center calculated annual program costs and savings by customer class. Program costs for both RCI-7 and RCI-3 were computed by multiplying the annual energy savings achieved by a given technology, as determined by the RCI technical working group, by the first-year investment costs for that technology. First-year investment costs were calculated by the ASU Energy Center by decomposing each technology's "Levelized Cost per Unit of Output," based on the annualization factors cited by the RCI technical working group*. In a similar fashion, annual fuels costs associated with bioenergy technologies were calculated by multiplying annual energy savings by the RCI technical working group's state fuel prices. These costs were then summed by customer class and allocated as reductions in final demand according to a given sector's Energy Consumption Coefficient.

The distribution of energy savings by customer class and economic sector for RCI-7 and RCI-3 were calculated by summing the cumulative energy savings achieved by a given technology for a given customer class, as determined by the RCI technical working group, multiplying by the RCI technical working group's retail price forecast. These values were then allocated to each economic sector according to its Energy Consumption Coefficient and treated as an increase in final demand. The resulting reduction in revenue for utility sectors is treated as a reduction in final demand for those sectors. Significantly it was assumed that only a portion of the monetary value of energy savings would impact the North Carolina economy, as industries and consumers import a percentage of goods and services from outside the state.

Investments resulting from the implementation of RCI-7 and RCI-3 were allocated according to the characteristics of the technology. Energy efficiency investments were allocated according to the methodology described for RCI 1, 2 & 11. Conservatively it was assumed that only the labor share of capital expenditures for distributed renewable energy systems would impact the North Carolina economy. The labor share of capital investments in solar thermal and photovoltaic systems were distributed to the Residential Construction sector, while the labor share of bioenergy systems were distributed to Heavy Construction. Notably, the RCI technical working group analysis does not consider ongoing operating and maintenance costs. Fuel and feedstock expenditures associated with bioenergy investments were distributed equally among the Animal Production, Forestry, and Waste Management sectors.

Finally it was assumed that a portion of the financing costs associated with investments would benefit the local Financial, Insurance, and Real Estate sector and that the displacement of new conventional electricity generation results in a reduction in Final Demand for the Heavy Construction and Electric Utility sectors.

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* The RCI technical working group analysis only considers fuel costs associated with bioenergy technologies and does not specify a levelized cost for capital investments, therefore the ASU Energy Center relied on the levelized cost estimates derived by the Energy Supply technical working group for bioenergy technologies (Center for Climate Strategies 2007b).

The table below summarizes the key variables and assumptions used to derive the net annual changes in final demand resulting from implementation of the mitigation option.

Variable/Assumption	Value
Decomposed First-year Cost, Energy Efficiency, Electric ($/MWh)[a]	$492.79
Decomposed First-year Cost, Energy Efficiency, Natural Gas ($/MWh)[a]	$71.23
Decomposed First-year Cost, Solar Hot Water ($/MMBtu)[a]	$203.95 (in 2007), 183.55 (in 2020)
Decomposed First-year Cost, On-site Photovoltaic ($/MWh)[a]	$203.95 (in 2007), 183.55 (in 2020)
Decomposed First-year Cost, On-site Bioenergy ($/MWh)[b]	$331 (in 2007),$328 (in 2020)
Fuel Cost for On-site Bioenergy ($/MMBtu)[c]	$2.38
Share of Total Energy Efficiency Investments to Residential Construction[d]	35.9%
Share of Total Energy Efficiency Investments to Commercial Construction[e]	27.2%
Share of Total Energy Efficiency Investments to Wholesale Trade[e]	6.5%
Share of Total Energy Efficiency Investments to Retail Trade[d]	20.7%
Share of Total Energy Efficiency Investments to Professional, Scientific, Technical & Management Services[e]	3.2%
Share of Energy Efficiency Investments to Other Services[e]	6.5%
Share of Solar Hot Water and Photovoltaic Investments to Residential Construction[f]	30%
Share of Bioenergy Investments to Residential Construction[g]	16.7%
Share of Fuel and Feedstocks to Animal Waste, Forestry, and Waste Management[h]	33.3%
Financing Assumptions, Residential[i] Interest rate Fraction financed Term Fraction Local Borrowing	 8% 80% 25 years 64.2%
Financing Assumptions, Commercial[b] Interest rate Fraction financed Term Fraction Local Borrowing	 8% 80% 25 years 64.2%
Financing Assumptions, Industrial[b] Interest rate Fraction financed Term Fraction Local Borrowing	 8% 80% 25 years 64.2%

[a] Source: Calculation based on levelized cost of $34.97/MWh (electric) and $5.05/MMBtu (natural gas) cited in (Center for Climate Strategies 2007c).
[b] Source: Calculation based on an equally weighted hybrid of levelized costs of municipal biogas, dedicated biomass, and hog waste biomass cited in(Center for Climate Strategies 2007b).
[c] Source: (Center for Climate Strategies 2007b).
[d] Source: (GDS Associates 2006). Weighted for distribution of spending among customer classes.
[e] Source: (Sedano 2005). Weighted for distribution of spending among customer classes.
[f] Source: (LaCapra Associates 2006). Assumes solar thermal and photovoltaic have similar labor shares.
[g] Source: (LaCapra Associates 2006). Assumes average of landfill gas, hog waste, and direct biomass labor shares.
[h] Assumption.
[i] Assumption. Local borrowing based on regional purchase coefficient for Financial, Insurance, and real estate sector in (Minnesota IMPLAN Group 2005).

RCI-9: Bulk Purchasing for Energy Efficient Appliances

Using the assumptions of the RCI technical working group, the ASU Energy Center computed annual program costs and savings by customer class. In its analysis of the bulk purchasing component, the RCI technical working group calculated annual energy savings for government and nongovernmental participants. The ASU Energy Center distributed nongovernmental energy savings to the residential, commercial, and industrial customer classes in proportion to a customer class' share of reference case sales. Program costs by customer class for the bulk purchasing component were then calculated by multiplying energy savings by customer class by the RCI technical working group's "assumed cost of bulk purchase program savings." Nongovernmental program costs were allocated as a reduction in final demand according to a sector's Energy Consumption Coefficient. Governmental program costs were assumed to come from existing state revenues and therefore will result in a reduction in state government expenditures, and in final demand, according to a sector's Government Spending Coefficient. Investments in energy efficiency measures resulting from the implementation of the bulk purchasing component were allocated to Retail Trade.

In a similar fashion, the ASU Energy Center calculated the monetary value of physical energy saving from the bulk purchasing component with nongovernmental energy saving by customer class multiplied by the RCI technical working group's energy price forecast by customer class and governmental energy savings multiplied by the price forecast for the commercial sector. The monetary value of nongovernmental energy savings was then allocated to each economic sector according to its Energy Consumption Coefficient; while the value of governmental savings was allocated directly to the government sector. In both instances the savings were treated as an increase in final demand. The resulting reduction in revenue for utility sectors is treated as a reduction in final demand for those sectors. Significantly it was assumed that only a portion of the monetary value of energy savings would impact the North Carolina economy, as industries and consumers import a percentage of goods and services from outside the state.

Finally it was also assumed that a portion of the financing costs associated with investments would benefit the Financial, Insurance, and Real Estate sector. Finally, the displacement of new conventional electricity generation is reflected as a reduction in Final Demand for the Heavy Construction and Electric Utility sectors.

The table below summarizes the key variables and assumptions used to derive the net annual changes in final demand resulting from implementation of the mitigation option.

Variable/Assumption	Value
Assumed cost of bulk purchase program savings, ($/MWh)[a]	$12.00
Financing Assumptions, Residential [b]	
Interest rate	8%
Fraction financed	85%
Term	10 years
Fraction Local Borrowing	64.2%

Financing Assumptions, Commercial [b]	
Interest rate	8%
Fraction financed	85%
Term	15 years
Fraction Local Borrowing	64.2%
Financing Assumptions, Industrial [b]	
Interest rate	8%
Fraction financed	85%
Term	15 years
Fraction Local Borrowing	64.2%

[a] Source:(Center for Climate Strategies 2007c).
[b] Assumption. Local borrowing based on regional purchase coefficient for Financial, Insurance, and real estate sector in (Minnesota IMPLAN Group 2005).

RCI-10: Solar Hot Water Heating Only

Utilizing the values developed by the RCI technical working group the ASU Energy Center calculated annual program costs and savings by customer class. Annual program costs were determined by multiplying the annual number of additional households using Solar Hot Water Heating (SHW) systems as a result of the mitigation option by the incremental capital cost of the system, as determined by the RCI technical working group. It was assumed that these investments would be financed by the program participants and that a portion of the financing costs would benefit the local Financial, Insurance, and Real Estate sector. Conservatively, it was assumed that only the labor portion of the capital investments associated with the mitigation option implementation would impact the North Carolina economy, increasing final demand for Residential Construction.

The dollar value of avoided energy consumption was calculated by multiplying the physical energy savings by fuel type by the retail price forecast, as stated by the RCI technical working group. It was assumed these savings would benefit the Household sector as an increase in final demand, while the resulting reduction in revenue for energy utilities would result in a reduction in final demand for those sectors. Finally, the displacement of new conventional electricity generation is reflected as a reduction in Final Demand for the Heavy Construction and Electric Utility sectors.

The table below summarizes the key variables and assumptions used to derive the net annual changes in final demand resulting from implementation of the mitigation option.

Variable/Assumption	**Value**
Incremental Capital Cost of SHW Installation, ($/installation) [a]	$3,500 (in 2007), $3,050 (in 2020)
Share of Solar Hot Water Investments to Residential Construction[b]	30%
Financing Assumptions [c]	
Interest rate	8%
Fraction financed	85%
Term	7 years
Fraction Local Borrowing	64.2%

[a] Source: (Center for Climate Strategies 2007c).
[b] Source:(LaCapra Associates 2006). Assumes solar thermal and photovoltaic have similar labor shares.
[c] Assumption. Local borrowing based on regional purchase coefficient for Financial, Insurance, and real estate sector in (Minnesota IMPLAN Group 2005).

AFW-1: Manure Digesters

Utilizing the technology cost and performance assumptions developed by the AFW technical working group, the ASU Energy Center calculated annual capital investments and operating costs required to meet the implementation schedule articulated in the mitigation option description. Likewise, the assumptions of the AFW technical working group were used to derive the dollar value of electricity generated from the implementation of the mitigation option.

In modeling this option, it was assumed the costs of implementation would be borne by the Animal Production sector of the economy and be reflected as a reduction in final demand for this sector. In turn, it was assumed the value of electricity produced by this mitigation option would benefit the Animal Production sector as an increase in final demand for this sector while the resulting reduction in revenue for the Electric Utility sector would result in a reduction in final demand for that sector.

Conservatively, it was assumed that only the labor portion of the capital investments and operating expenses associated with the mitigation option implementation would impact the North Carolina economy. The labor share of capital investments increases final demand for Heavy Construction while the labor share of operating expenses increases final demand for Animal Production. It was also assumed that a portion of the financing costs associated with investments would benefit the Financial, Insurance, and Real Estate sector. Finally, the displacement of new conventional electricity generation is reflected as a reduction in Final Demand for the Heavy Construction and Electric Utility sectors.

The table below summarizes the key variables and assumptions used to derive the net annual changes in final demand resulting from implementation of the mitigation option.

Variable /Assumption	Value
Capital Cost ($/head, dairy cattle)[a]	$394
Annual O&M ($/head, dairy cattle)[b]	$38
Capital Cost ($/head, swine)[c]	$72
Annual O&M ($/head, swine)[b]	$8
Value of Electricity Savings ($/MWh)[b]	$50
Financing Assumptions (interest rate, fraction borrowed, term)[d]	5%, 100%, 15 years
Labor Share of Renewables Capital Investment[e]	30%
Labor Share of Renewables O&M Expenses[e]	30%
Labor Share of Displaced Conventional Capital Investment[e]	26.5%
Labor Share of Displaced Conventional Operating Expenses[e]	42%

[a] Source:(Center for Climate Strategies 2007a). Assumes midpoint of "low" and "high" capital cost.
[b] Source: (Center for Climate Strategies 2007a).
[c] Source:(Center for Climate Strategies 2007a). Outlays attributable to Animal Production reflect 30% federal subsidy.
[d] Assumption.
[e] Source: (LaCapra Associates 2006).

AFW-2: Biodiesel Production Subsidy*

The annual cost of providing the subsidy was obtained from the AFW technical working group analysis. To determine the value of annual capital investments, operating costs and feedstock production the Energy Center conducted additional research. The capital costs and operating expenses per gallon of biodiesel production were derived from the same U.S. Department of Energy, Energy Information Administration study used by the AFW technical working group to estimate the per gallon subsidy. The value of feedstock production was derived from a U.S. Department of Agriculture forecast of corn and soybean commodity prices (U.S. Department of Agriculture 2007) and assumed a yield of .13 gallons of oil per pound soybean feedstock (Duffield and Shapouri 1998).

Conservatively, it was assumed that only the construction portion of the capital investments and labor portion of operating expenses associated with the mitigation option implementation would impact the North Carolina economy. The construction portion of capital investments increase final demand for Commercial Construction while the labor share of O&M expenses increase final demand for the Fats and Oils Manufacturing sector. The value of feedstock production was distributed to various agricultural sub-sectors according to the proportions listed in the AFW technical working group's technical appendix. It was also assumed that a portion of the financing costs associated with investments would benefit the local Financial, Insurance, and Real Estate sector. Finally, it was assumed that the easement payments come from existing state revenues and therefore will result in corresponding reduction in other state government expenditures, excluding education.

The table below summarizes the key variables and assumptions used to derive the net annual changes in final demand resulting from implementation of the mitigation option.

Variable /Assumption	Value
State Subsidy ($/gallon) [a]	$0.34
Capital Cost ($/gallon of production)[b]	$1.13
Annual O&M ($/gallon of production) [b]	$0.34
Value of Feedstock Oil ($/gallon of production)[c]	$.04
Share of Capital Investment Attributable to Commercial Construction[d]	19.2%
Labor Share of O&M Expenses Attributable to Fats & Oils Manufacturing[e]	27%
Financing Assumptions (interest rate, fraction borrowed, term)[f]	8%, 50%, 15 years

[a] Source: (Center for Climate Strategies 2007a).
[b] Source: (Radich 2004). Adjusted to 2004 dollars.
[c] Source: (Duffield and Shapouri 1998; U.S. Department of Agriculture 2007)
[d] Source: (De La Toore Ugarte 2006).
[e] Source:(Swenson 2006; Paulson and Ginder 2007).
[f] Assumption.

* The CAPAG's baseline estimates of biodiesel production do not reflect the increases in biodiesel production mandated by the December 2007 passage of the Energy Independence and Security Act which requires the nationwide production of 36 billion gallons of renewable transportation fuels by 2022.

AFW-4A & AFW-4B: Farmland and Forestland Conservation Easements

Utilizing the program cost assumptions and implementation schedule developed by the AFW technical working group, the Energy Center calculated the annual public investment required to meet the goals articulated in the mitigation option descriptions. Relying on similar studies that modeled the economic impacts of land conservation programs, easement payments are treated as income transfers to households (Cartwright 2006). Notably, the AFW technical working group assumes that farmland easements are supplemented through a cost share with the U.S. Department of Agriculture's Natural Resource Conservation Service or some other source. In modeling this option, it was assumed that this cost share is from an exogenous source. Finally, it was assumed that the easement payments come from existing state revenues and therefore will result in corresponding reduction in other state government expenditures, excluding education.

The table below summarizes the key variables and assumptions used to derive the net annual changes in final demand resulting from implementation of the mitigation option.

Variable/Assumption	Value
State Farmland Easement Payment ($/acre under easement)[a]	$1,029.50
Exogenous Farmland Easement Payment ($/acre under easement)[a]	$1,029.50
State Forestland Easement Payment ($/acre under easement)[a]	$1,300

[a] Source: (Center for Climate Strategies 2007a).

AFW-6: Cellulosic Ethanol Production Subsidy

The annual cost of providing the subsidy was obtained from the AFW technical working group analysis. To determine the value of annual capital investments, operating costs and feedstock production the Energy Center conducted additional research. Precise figures for capital investment per gallon of cellulosic ethanol production were difficult to obtain, as no large-scale commercial plants are currently operating. Instead, the ASU Energy Center applied the AFW technical working group's assumption of a 15% differential between the costs of producing starch-based and those of cellulosic ethanol production to capital cost estimates for starch-based ethanol plants compiled by the U.S. Department of Agriculture (Gallagher and Shapouri 2005). The same source and procedure is used to derive the labor share of operating expenses. The value of feedstock production was based on the price of biomass feedstocks utilized by the CAPAG's Energy Supply technical working group (Center for Climate Strategies 2007b).

Conservatively, it was assumed that only the construction portion of the capital investments and labor portion of operating expenses associated with the mitigation option implementation would impact the North Carolina economy. The construction portion of capital investments increase final demand for Commercial Construction while the labor share of O&M expenses increase final demand for the Fats and Oils Manufacturing sector. The value of feedstock production was allocated to the Forestry sector. It was also assumed that a portion of the financing costs associated with investments would benefit the local Financial, Insurance, and Real Estate sector. Finally, it was assumed that the subsidy payments come from existing state revenues and therefore will result in corresponding reductions in other state government expenditures.

The table below summarizes the key variables and assumptions used to derive the net annual changes in final demand resulting from implementation of the mitigation option.

Variable/Assumption	Value
State Subsidy ($/gallon of production through 2015)[a]	$0.23
Capital Cost through 2015 ($/gallon of production)[b]	$2.50
Capital Cost after 2015 ($/gallon of production)[b]	$2.17
Labor share of O&M expenses through 2015 ($/gallon of production)[b]	6.8%
Labor share of O&M expenses after 2015 ($/gallon of production)[b]	5.9%
Value of Feedstock ($/gallon of production)[c]	$51
Share of Capital Investment Attributable to Commercial Construction[d]	17.5%
Financing Assumptions (interest rate, fraction borrowed, term)[e]	8%, 50%, 20 years

[a] Source: (Center for Climate Strategies 2007a).
[b] Source: (Gallagher and Shapouri 2005). Assumes 15% increase applied to midpoint of $2.00/gallon and adjusts for inflation using U.S. Consumer Price Index. After 2015, modeling assumes cellulosic ethanol capital cost per gallon is equal to starch-based costs per the assumptions of the AFW technical working group.
[c] Source: (Hag 2002; Center for Climate Strategies 2007b). Price per MMBtu converted to price per dry ton based on heat content of 8,600 Btu per pound.
[d] Source: (Swenson 2006).
[e] Assumption.

AFW-8: AFFORESTATION

Utilizing the program cost assumptions and implementation schedule developed by the AFW technical working group, the Energy Center calculated the annual public investment required to meet the goals articulated in the mitigation option descriptions. It was assumed that the cost of the subsidy comes from existing state revenues and therefore will result in corresponding reduction in other state government expenditures, excluding education.

To determine the value of change in rent payment for affected lands the Energy Center conducted additional research. The impact on households of the CRP-type rent payments was determined by taking the difference in the subsidy payment and the average statewide cash rent value of "low productivity" agricultural lands and multiplying it by the number of acres affected. After five years, the value of land rent is based on an Annual Equivalent Value (AEV) estimate from the literature. The resulting net rent is reflected as income transfers to households. It was further assumed that the annual value of the establishment costs would result in an increase in final demand for the Forestry sector.

The table below summarizes the key variables and assumptions used to derive the net annual changes in final demand resulting from implementation of the mitigation option.

Variable/Assumption	Value
State Cost Share for Establishment ($/acre)[a]	$140
State CRP type Rent Payment ($/acre for first five years)[a]	$40
Average Statewide Cash Rent Value of "Low Productivity" Agricultural Lands ($/acre)[b]	$28.40
Annual Equivalent Value of Afforested Lands ($/acre)[c]	$159.53

[a] Source:(Center for Climate Strategies 2007a).
[b] Source:(N.C. Department of Agriculture and Consumer Services 2006).
[c] Source:(Dangerfield 1998). Modeling assumes AEV for future forest harvest is annuity payment and adjusts for inflation using U.S. Consumer Price Index.

AFW-9 & AFW-10: Forest Management

Utilizing the program cost assumptions and implementation schedule developed by the AFW technical working group, the Energy Center calculated the annual public investment required to meet the goals articulated in the mitigation option descriptions. It was assumed that the cost of the subsidy comes from existing state revenues and therefore will result in corresponding reduction in other state government expenditures, excluding education. It was further assumed that the annual value of the productivity improvement costs would result in an increase in final demand for the Forestry sector. The future value of the higher yields predicted to result from the mitigation option were converted to an Annual Equivalent Value basis and treated as an annuity payment split among the Household and the Forestry sectors based on the share of private forest ownership in North Carolina.

The table below summarizes the key variables and assumptions used to derive the net annual changes in final demand resulting from implementation of the mitigation option.

Variable/Assumption	Value
State Cost Share for Productivity Improvements ($/acre)[a]	$8.80
Annual Equivalent Value of Future Value of Increased Forest Product Yields ($/acre)[b]	$15.09
Private Landowner Share of North Carolina Private Forest Ownership [c]	89.7%
Forestry Industry Share of North Carolina Private Forest Ownership [c]	10.3%

[a] Source:(Center for Climate Strategies 2007a).
b Source:Calculation based on values in(Center for Climate Strategies 2007a). Assumes investment period of 17 years and discount rate of 5%.
[c] Source:(Brown 2004).

AFW-11: LANDFILL GAS

Utilizing the technology cost and performance assumptions developed by the AFW technical working group, the Energy Center calculated annual capital investments and operating costs required to meet the implementation schedule articulated in the mitigation option description. First, the ASU Energy Center determined the annual number of projects by technology type that would have to be implemented to meet the emissions reductions assumed by the AFW technical working group. This was done by multiplying the total annual emissions reduction by the stated share of those reductions by technology type and dividing the technology's average annual emissions reduction rate.

For example, assume the total annual emissions reduction for a given year is .073 MMTCO2e. According to the AFW technical working group, 63% of these emissions reductions come from small engine generator projects which achieve an average annual emissions reduction of .023 MMTCO2e. Therefore, in this example, it would be necessary to install two small engine generator projects in this year to meet the emissions reductions target. Once the annual number of project equivalents was determined, the ASU Energy Center then multiplied this number by the total capital cost and average annual operating costs derived by the AFW technical working group from the EPA's Landfill Gas Cost Model.

Likewise, the assumptions of the CAPAG and AFW technical working group were used to derive the dollar value of electricity generated from the implementation of the mitigation option. The annual energy consumption by technology type stated by the AFW technical working group was multiplied by the industrial energy prices from the Residential, Commercial, and Industrial technical working group.

In modeling this option, it was assumed the costs of implementation would be borne by the Waste Management sector and are reflected as a reduction in final demand for this sector. In turn, it was assumed the value of electricity produced by this mitigation option would benefit the Waste Management sector as an increase in final demand, while the resulting reduction in revenue for the Electric Utility sector would result in a reduction in final demand for that sector.

Conservatively, it was assumed that only the labor portion of the capital investments and operating expenses associated with the mitigation option implementation would impact the North Carolina economy. The labor share of capital investments increases final demand for Heavy Construction while the labor share of operating expenses increases final demand for the Electric Utility sector. It was also assumed that a portion of the financing costs associated with investments would benefit the Financial, Insurance, and Real Estate sector. Finally, the displacement of new conventional electricity generation is reflected as a reduction in Final Demand for the Heavy Construction and Electric Utility sectors.

The table below summarizes the key variables and assumptions used to derive the net annual changes in final demand resulting from implementation of the mitigation option.

Variable/Assumption	Value
Average Annual Emissions Reductions for Small Engine Generator Installations (MMTCO2e/project equivalent)[a]	0.023
Capital Cost for Small Engine Generator Installations ($/project equivalent)[a]	753,365
Operating Expense for Small Engine Generators ($/project equivalent)[a]	102,141
Average Annual Emissions Reductions for Direct Use Installations (MMTCO2e/project equivalent)[a]	0.024
Capital Cost for Direct Use Installations ($/project equivalent)[a]	621,573
Operating Expense for Direct Use Installations ($/project equivalent)[a]	105,474
Average Annual Emissions Reductions for Small Engine Generator Installations (MMTCO2e /project equivalent)[a]	0.088
Capital Cost for Standard Engine Generators Installations ($/project equivalent)[a]	2,612,674
Operating Expense for Standard Engine Generators Installations ($/project equivalent)[a]	335,475
Financing Assumptions (interest rate, fraction financed, term, local borrowing)[b]	8%,100%, 10 years, 64.2%
Labor Share of LFG Capital Investment[c]	10%
Labor Share of LFG O&M Expenses[b]	40%
Labor Share of Displaced Conventional Capital Investment[b]	26.5%
Labor Share of Displaced Conventional Operating Expenses[b]	42%

[a] Source:(Center for Climate Strategies 2007a).
[b] Financing assumption based on (Center for Climate Strategies 2007a) . Local borrowing based on regional purchase coefficient for Financial, Insurance, and real estate sector in (Minnesota IMPLAN Group 2005).
[c] Source:(LaCapra Associates 2006). Displaced investments in conventional generation assumes a fuel mix of 60% pulverized coal and 40% combined cycle natural gas per the CAPAG Energy Supply technical working group reference case(Center for Climate Strategies 2007b).

AFW-12: Recycling

Utilizing the program cost assumptions and implementation schedule developed by the AFW technical working group, the ASU Energy Center calculated the annual private investment required to meet the goals articulated in the mitigation option description and the resulting savings. Notably, the AFW technical working group assumes a constant program implementation cost based on full achievement of the mitigation option goal. This assumption likely overstates the actual costs incurred in a given year. Therefore, the ASU Energy Center calculated the annual private investment based on the annual achievement of GHG emission reductions reported by the AFW technical working group. The incremental GHG reductions in a given year were divided by the GHG reductions in 2020 yielding an "implementation coefficient" (see table below). This coefficient was then used to calculate the number of existing and new households participating in the program as well as the incremental recycled tonnage in a given year. These values in turn were multiplied to by the program costs and savings stated by the AFW technical working group to yield annual private investment and savings.

Year	CO_2 Reduced (MMte)[a]	Implementation Coefficient
2007	0.05	0.10
2008	0.10	0.20
2009	0.15	0.30
2010	0.20	0.40
2011	0.23	0.46
2012	0.25	0.52
2013	0.28	0.58
2014	0.31	0.64
2015	0.34	0.70
2016	0.37	0.76
2017	0.40	0.82
2018	0.43	0.88
2019	0.46	0.94
2020	0.49	1.00

[a] Source:(Center for Climate Strategies 2007a).

In modeling this option, it was assumed that the program costs would be borne by the Household sector of the economy and conversely savings would accrue to the Household sector. It was also assumed that the private expenditures associated with the program would benefit the Waste Management sector and conversely program savings would cost the Waste Management sector.

The table below summarizes the key variables and assumptions used to derive the net annual changes in final demand resulting from implementation of the mitigation option.

Variable/Assumption	Value
Household Subject to Mitigation option at Full Implementation with Existing Recycling Services [a]	1,384,653
Household Subject to Mitigation option at Full Implementation without Existing Recycling Services [a]	516,914
Recycled Tonnage at Full Mitigation option Implementation [a]	134,539
Program Cost for Enhanced Service ($/Household with existing service) [a]	$.60
Program Cost for New Service ($/Household without existing service) [a]	$27.00
Avoided Tipping Fee ($/ton) [a]	$35.00

[a] Source:(Center for Climate Strategies 2007a).

AFW-13: URBAN FORESTRY

Utilizing the program cost assumptions and implementation schedule developed by the AFW technical working group, the ASU Energy Center calculated the annual private investment required to meet the goals articulated in the mitigation option descriptions and the resulting energy savings. In modeling this option, it was assumed that the program costs would be borne by the Household sector of the economy and that conversely savings would also accrue to this sector. The cost savings realized by the program are lost revenue for energy providers and are reflected as reductions in final demand based on the share of energy savings by fuel type.

To determine the impact of the program expenditures on a given sector of the economy, the Energy Center conducted additional research. The AFW technical working group assumes a program cost of $250 per tree, based on a U.S. Department of Agriculture, U.S. Forest Service study of urban forestry programs in Chicago, IL. describing a range of urban forestry programs and their costs (planting, pruning, infrastructure repair, liability, etc.) (McPherson 1994). In modeling this option it was assumed that a North Carolina program would mirror the Residential Yard Tree program described in this study. The share of the program costs attributable to planting costs was allocated to the Retail Trade sector of the economy, which includes building and garden store retailers. The share of the program costs attributable to pruning was allocated to the Other Services sector of the economy, which includes services to buildings and dwellings. The share of program costs attributable to infrastructure repair was allocated to Residential Construction sector. The share of program costs attributable to liability was allocated to the Financial, Insurance, and Real Estate sector. Finally, the displacement of new conventional electricity generation is reflected as a reduction in Final Demand for the Heavy Construction and Electric Utility sectors.

The table below summarizes the key variables and assumptions used to derive the net annual changes in final demand resulting from implementation of the mitigation option.

Variable/Assumption	Value
Share of Program Costs for Planting [a]	49%
Share of Program Costs for Pruning [a]	38%
Share of Program Costs for Infrastructure Repair [a]	10%
Share of Program Costs for Liability [a]	3%
Share of Energy Savings, Electricity [b]	61.1%
Share of Energy Savings, Natural Gas [b]	30.8%
Share of Energy Savings, Propane [b]	5.3%
Share of Energy Savings, Fuel Oil [b]	2.4%
Financing Assumptions (interest rate, fraction borrowed, term)[c]	8%, 80%, 30 years

[a] Source:(McPherson 1994).
[b] Source:(Center for Climate Strategies 2007a).
[c] Assumption.

TLU-1B: Multi-modal Transportation and Promotion

In order to estimate the economic impacts associated with the shift in transportation funding proposed by the mitigation option, the ASU Energy Center conducted additional research to determine the likely allocation of investments in particular multimodal projects and the subsequent distribution of these investments across the North Carolina economy. The allocation of investments in particular multimodal projects were based on the goals articulated in the Statewide Transportation Plan (N.C. Department of Transportation 2004)*. The subsequent distribution of these investments across the economy was based on a comprehensive economic impact study of public transportation investments (Cambridge Systematics 1999).

Conservatively, the ASU Energy Center assumed the monetary savings associated with the implementation of the mitigation option were limited to fuel savings resulting from projected VMT reductions rather than the TLU technical working group's more generous assumption of a 1.5x cost savings multiplier. The value of avoided fuel consumption was calculated by dividing projected annual VMT reductions by the U.S. Department of Energy, Energy Information Administration's (EIA) light duty vehicle fuel economy forecast (Energy Information Administration 2007b) and multiplying the result by the EIA's retail gasoline price forecast for the South Atlantic Region (Energy Information Administration 2007d)†. Since the TLU technical working group only presented projected annual VMT reductions for 2010 and 2020, to calculate annual VMT reduction for the intervening period the ASU Energy Center assumed VMT reductions occurred in equal incremental steps. The monetary savings associated with these reduced vehicle operating costs were treated as an increase in final demand for the Household sector. Conversely, the reduction in retail gasoline sales was treated as a decrease in final demand for the Retail sector. Notably, only the value of the retail margin or markup, as determined by IMPLAN coefficients, was considered.

The table below summarizes the key variables and assumptions used to derive the net annual changes in final demand resulting from implementation of the mitigation option.

* It was assumed that spending under the "recommended scenario" would parallel the type of investments articulated in the report's description of the "25-year needs." For example, it was assumed "transit" funding would include both a mix of light rail and bus service.

† The EIA's 2007 light duty vehicle fuel economy forecast does not account for the mandated increase in vehicle fuel economy mandated by December 2007 passage of the Energy Independence and Security Act which requires a Corporate Average Fuel Economy of 35 miles per gallon for light duty vehicles by 2020.

Variable/Assumption	Value
Share of Transit Funding, Bus Service, Capital Expenditures[a]	33%
Share of Transit Funding, Bus Service, Operating Expenditures [a]	14%
Share of Transit Funding, Light Rail, Capital Expenditures [a]	37%
Share of Transit Funding, Light Rail, Operating Expenditures [a]	14%
Share of Transit Funding, Bike & Pedestrian, Capital Expenditures [a]	3%
Share of Total Transit Investments to Vehicle Manufacturing[b]	7%
Share of Total Transit Investments to Heavy Construction [b]	27%
Share of Total Transit Investments to Commercial Construction [b]	6%
Share of Total Transit Investments to Transit Transportation [b]	28%

[a] Source: Calculation based goals in (N.C. Department of Transportation 2004).
[b] Source: Calculation based conversion of REMI sectors in (Cambridge Systematics 1999) to IMPLAN sectors; includes accounting for regional purchase coefficients.

TLU-3A: Vehicle Registration Surcharge to Fund Multi-modal Transportation

In modeling this option the ASU Energy Center assumed that additional investments in multi-modal transportation projects would follow the recommendations set forth in the Statewide Transportation Plan. The allocation and distribution of these investments, the annual VMT reductions, and the monetary savings associated with reduced vehicle operating costs followed the same methodology as utilized in the analysis of TLU 1b. Additionally it was assumed the cost of compliance would be borne by the Household sector of the economy.

The table below summarizes the key variables and assumptions used to derive the net annual changes in final demand resulting from implementation of the mitigation option.

Variable/Assumption	Value
Share of Transit Funding, Bus Service, Capital Expenditures[a]	33%
Share of Transit Funding, Bus Service, Operating Expenditures[a]	14%
Share of Transit Funding, Light Rail, Capital Expenditures[a]	37%
Share of Transit Funding, Light Rail, Operating Expenditures[a]	14%
Share of Transit Funding, Bike & Pedestrian, Capital Expenditures[a]	3%
Share of Total Transit Investments to Vehicle Manufacturing[b]	7%
Share of Total Transit Investments to Heavy Construction[b]	27%
Share of Total Transit Investments to Commercial Construction[b]	6%
Share of Total Transit Investments to Transit Transportation[b]	28%

[a] Source: Calculation based goals in (N.C. Department of Transportation 2004).
[b] Source: Calculation based conversion of REMI sectors in (Cambridge Systematics 1999) to IMPLAN sectors; includes accounting for regional purchase coefficients.

TLU-5: Tailpipe Greenhouse Gas Emissions Standards

The TLU technical working group analysis did not provide inputs in the format required for the NCESEIM, therefore the ASU Energy Center conducted additional research. Overall, this approach yields a slightly more optimistic estimate of greenhouse gas reductions than estimated by the CAPAG.

The California tailpipe greenhouse gas emissions regulations, also known as Pavley standards, require light duty vehicles to achieve an emissions factor of 205 grams of CO_2e per mile traveled by 2016 down from 323 grams of CO_2e in 2009 (California Environmental Protection Agency 2005). These emissions reductions are expected to be achieved primarily through gains in fuel economy, air conditioning system performance, and advances in other vehicle technologies. The ASU Energy Center assumed that 95% of the greenhouse gas emissions reductions would be achieved through fuel economy improvements that would reduce vehicle fuel consumption and operating costs.

To convert the target emissions factors required by the Pavley standards into fuel savings, the ASU Energy Center first divided the U.S. Environmental Protection Agency, Office of Transportation and Air Quality's average carbon dioxide emissions rate from a gallon of gasoline (8,788 grams per gallon) by the adjusted target emission factors assumed by the ASU Energy Center. The result is a quasi-fuel economy standard measured in miles per gallon. Next, annual fuel consumption under Pavley-type regulations was calculated by dividing the product of the U.S. Department of Energy, Energy Information Administration's(EIA) projected average annual vehicle miles traveled (Energy Information Administration 2007c) and the calculated number of vehicles subject to the regulation by the quasi-fuel economy standards*.

The number of vehicles subject to regulation in a given year was determined by estimating North Carolina's share of EIA's projected regional new vehicle sales (Energy Information Administration 2007a). According to data published by the National Automobile Dealers Association, North Carolina's share of regional new vehicle sales is approximately 14% (Taylor 2007). The ASU Energy Center assumed this share remains constant over the study period.

The resulting Pavley-fleet fuel consumption projections were then compared to a baseline assessment calculated in a similar fashion but using EIA's projected fuel economy performance for light duty vehicles (Energy Information Administration 2007b) †. The difference between these two values represents the net fuel savings associated with a Pavley-type regulation. The monetary value of these net savings was then calculated using EIA's projected retail fuel price forecast for gasoline (Energy Information Administration 2007d). Notably, the EIA fuel price forecasts are considerably lower than current market prices.

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* The EIA's projected average annual vehicle miles traveled does not account for any "rebound effect," that is the effect of drivers increasing miles travelled because driving on a per unit basis has become cheaper. Some studies suggest that the rebound effect may be as high 10-20% over the long run (see for example Small and Dender 2007).

† The EIA's 2007 light duty vehicle fuel economy forecast does not account for the mandated increase in vehicle fuel economy mandated by December 2007 passage of the Energy Independence and Security Act which requires a Corporate Average Fuel Economy of 35 miles per gallon for light duty vehicles by 2020.

These monetary savings, in turn, were treated as an increase in final demand for the Household sector. Conversely, the reduction in retail gasoline sales was treated as a decrease in final demand for the Retail sector. Notably, only the value of the retail margin or markup, as determined by IMPLAN coefficients, was considered.

Adoption of Pavley-type regulations will increase the upfront purchase price of new vehicles. In modeling the impact of these compliance costs to North Carolina consumers, the ASU Energy Center utilized the California Air Resources Board's annual per vehicle cost estimates and multiplied it by the number of vehicles subject to regulation in a given year (California Environmental Protection Agency 2005). It was assumed this cost of compliance would be borne by the Household sector of the economy. Additionally it was assumed that these costs would be financed as part of consumer automobile loan and that a portion of the financing costs would benefit the Financial, Insurance, and Real Estate sector.

The table below summarizes the key variables and assumptions used to derive the net annual changes in final demand resulting from implementation of the mitigation option.

Variable/Assumption	Value
Calculated Pavley quasi-fuel economy standard (miles per gallon)[a]	26.9 (in 2009), 40.7 (in 2020)
EIA projected fuel economy (miles per gallon)[b]	26.9 (in 2009), 28.2 (in 2020)
EIA Projected Fuel Price, gasoline ($/gallon, 2004)[c]	$2.14 (in 2009), $1.90 (in 2020)
Estimated New Vehicle Sales in North Carolina (thousands)[d]	436.6 (in 2009), 519.4 (in 2020)
EIA Annual Vehicle Miles Traveled[e]	13,000 (in 2009), 15,100 (in 2020)
Financing Assumptions (interest rate, fraction borrowed, term)[f]	8%, 95%, 5 years

[a] Calculation.
[b] Source:(Energy Information Administration 2007b).
[c] Source:(Energy Information Administration 2007d).
[d] Calculation.
[e] Source:(Energy Information Administration 2007c).
[f] Assumption.

APPENDIX C: SUMMARY OF PEER REVIEW COMMENTS AND RESPONSES

The Appalachian State University (ASU) Energy Center has received six anonymous reviews of the Draft Secondary Economic Impact Analysis of Greenhouse Gas (GHG) Mitigation Options for North Carolina ("Draft Report").

On the whole, reviewers were generally positive in their comments noting "the scope of the economic impacts that this research attempts to measure is impressive and ambitious;" that the written report was both "comprehensive and satisfactory;" and concluding "the ASU study reasonably captures the likely economic impacts of implementing the options identified by CAPAG." Additional positive comments include:

- "The use of an IMPLAN-based modeling approach is, therefore, reasonable for these magnitudes of policy changes relative to the North Carolina's economy as a whole."

- "Overall, the strength of the linked modeling approach lies in the expertise and procedures applied to the translation of policy options into direct economic impacts. Elements of each option were assessed for their impacts on industry behavior and final demand."

- "This manuscript summarizes an ambitious research effort to build a bridge between a multitude of greenhouse gas reduction options in North Carolina and the IO modeling framework so that state level economic impacts from adopting one or more of these options can be evaluated. There is an abundance of careful and thoughtful work on converting the options to reduce greenhouse gases to some accounting measures."

- "This paper is relatively clear to a professional steeped in interindustry models. I find no logical errors and am impressed by the sophistication of the analysis; it is superior to most impact analyses written over the last decade."

- "I must say that the document is superior to many I see. The logic seems sound and the inclusion of both positive and negative impacts of climate-mitigation options clearly shows that considerable
thought has gone into this work."

- "Using input output analysis to quantify the total (direct, indirect and induced) effects of the various mitigation strategies is standard practice and appropriate if the basic assumptions for the use of input-output analysis are met."

- "the specification of the input-output model follows similarly standard justification – using the best available studies and expert judgments to modify parameters in the existing IMPLAN and NCESEIM models. The impacts themselves were limited to those associated with the labor portion of any investment in new technology or capacity, essentially assuming that the impacts of the capital component of such investments on the economy are negligible. As the authors emphasize, this makes their study of contributions of mitigation strategies to the state's economy a rather conservative one."

That said, several of reviewers offered comments areas on how "the modeling approach might be enhanced, extended, and improved." The discussion below summarizes the primary points of concern raised by the reviewers and provides the Energy Center's response.

Comments relating to editorial-issues

A number of the reviewers made specific recommendations for editorial points of clarification as well as more general suggestions regarding "better documentation of assumptions, methodologies, and data taken from the literature."

- The Energy Center has made editorial corrections where appropriate and sought to clarify sections of the report identified as ambiguous or confusing. The Energy Center feels the request for additional documentation is unnecessary, as Appendix B provides substantial detail of the methodology and sources utilized by the Energy Center to prepare the report. However, the Energy Center inserted additional references in the main body of the report directing readers to Appendix B for more detail.

Comments relating to the Input-Output Model

Several of the reviews focused on the input-output economic model underlying the study and identified two basic sets of concerns: 1) the process by which the induced or Type II multipliers were computed and 2) the allocation of the monetary value of energy savings and operating costs to final demand. These reviews also made a number of clarifying suggestions related to the explanation of the derivation of the predictive multipliers in Appendix A.

- The Energy Center followed the advice of the reviewers related to the explanation of the derivation of the predictive multipliers in Appendix A and added a number of clarifying remarks.

- The questions raised by the reviewers related to the Type II multipliers revealed a computational error in the calculation of the household personal consumption expenditure (PCE) coefficients. This error resulted in an overstatement of the employment, income, and total value-added multipliers in the Draft Report. This error has been corrected and a new set of multipliers calculated. As a result, the magnitude of the impacts reported in final version of the report is considerably smaller. In some instances, options that were originally reported as having positive impacts, in fact, result in negative impacts.

- The allocation of energy savings and operating costs to a change in final demand is an admittedly coarse methodology for estimating the economic impacts associated with what in fact are fundamentally changes in intermediate demand. However, addressing this concern would require substantially greater modeling effort that is outside the scope of this analysis but is an issue the Energy Center plans on addressing in future versions of the model.

Comments relating to the lack of sensitivity analyses

Several of the reviews criticize both the Draft Report as well as the CAPAG report for a lack of sensitivity analyses.

- In fact, the Energy Center did prepare and present a limited set of sensitivity analyses for the April 22, 2008 Legislative Commission on Global Climate Change. However, these sensitivities were not incorporated into the Draft Report considered by the reviewers. The Energy Center has added an additional chapter to the final version that includes these sensitivities.

Comments relating to retail margins
At least one reviewer noted the distinction between producer and consumer prices associated with retail transactions and wondered about the utilization of retail margin factors.

- In fact, the NCESEIM does utilize retail margin factors when allocating transactions to retail sectors although the methodological description omitted this point. This is corrected in the final version of the report.

Comments related to local spending coefficients
At least one reviewer wondered how the NCESEIM determined local spending coefficients.

- Local spending coefficients are based on a weighted average of IMPLAN regional purchase coefficients for the affected sectors.

Comments related to discussion of model strengths and weaknesses
At least one reviewer suggested a more thorough discussion of the relative strengths and weaknesses of the modeling approach.

- The draft report does include a brief discussion of the limitations of input-output analysis. In the final report a footnote was added directing readers to additional sources to compare the input-output approach to the computable general equilibrium approach.

Comments related to discount rates
At least one reviewer was unable to locate the discount rate used to calculate Net Present Value.

- The discount rate used to calculate NPV is in a footnote on page 2 of the Executive Summary.

Several of these reviews took a broader approach and focused on how the NCESEIM translated the assumptions underlying the analysis of the N.C. Climate Action Plan Advisory (CAPAG) Technical Working Groups into the accounting framework required for the input-output model.

Comments related to the disaggregation of direct, indirect, and induced effects
At least one reviewer suggested results be presented in terms of their direct, indirect, and induced effects.

- This is not possible in the current version of the NCESEIM, but is an issue the Energy Center will address in future versions of the model.

Comments related to the relationship between impact results and GHG reductions
At least one reviewer suggested results be presented in terms of their GHG reductions.

- The draft report is intended to be a secondary analysis of the potential economic and jobs impacts of various GHG emissions reduction strategies developed by the North Carolina Climate Action Plan Advisory Group (CAPAG). The CAPAG has issued its own report detailing the potential GHG emissions reductions associated with a given policy option. To include these GHG reductions in the Draft Report is beyond the scope of analysis.

Comments related to baseline scenarios
At least one reviewer raised questions about the baseline scenarios used for analysis, especially in light of the passage of Energy Independence and Security Act in December 2007.

- The baseline scenarios were developed by the CAPAG Technical Working Groups (TWGs) prior to the passage of the Energy Independence and Security Act and reflected the best available information at the time. The Energy Center relied on the assumptions and analysis of the TWGs and therefore the Draft Results, likewise, do not reflect the passage of the Energy Independence and Security Act.

Comments related to the use "labor share" for capital investments and operating expenses

At least one reviewer raised questions about the use of labor shares.

- The use of labor shares follows the methodology of LaCapra and Associates in their assessment for the N.C. Utilities Commission of the economic impacts of the adoptions of a renewable energy portfolio standard. The Energy Center followed the same approach because we understood that while it may understated impacts it also provided a balance to some of the limitations of the input-output methodology.

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LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE

INTERIM REPORT TO THE ENVIRONMENTAL REVIEW COMMISSION AND THE GENERAL ASSEMBLY OF NORTH CAROLINA

2007 REGULAR SESSION

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22 February 2007

TO THE MEMBERS OF THE 2007 GENERAL ASSEMBLY

Pursuant to Session Law 2005-442, Sec. 11 as amended by Session Law 2006-73, the Legislative Commission on Global Climate Change submits its Interim Report to the Environmental Review Commission and the 2007 General Assembly.

Respectfully submitted,

John L.W. Garrou

Representative Joe Hackney

Co-Chairs
Legislative Commission on Global Climate Change

LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE

Membership

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Session Law 2005-442, which established the Legislative Commission on Global Climate Change, provides that the Commission shall consist of 34 members. 18 of these members are appointed by the President Pro Tempore of the Senate and the Speaker of the House of Representatives as indicated below. The remaining 16 members are ex officio voting members designated as indicated on the second part of this membership list.

President Pro Tempore of the Senate Appointments:

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[1] Currently, Ms Caroline Choi represented Progress Energy from January 2006 through August 2006. Ms Vicky K. Will represented Progress Energy from August 2006 through 31 January 2007. Ms Choi returned to the Commission as the representative of Progress Energy on 1 February 2007.

[2] Mr. Barry Eveland represented the North Carolina Citizens for Business and Industry from January 2006 through 21 August 2006.

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[3] Dr. Sethu Raman the State Climatologist from January 2006 through 1 July 2006, served as a member of the Commission.

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[4] Ms Mary Watson served as a Commission Clerk from 1 January 2006 through 28 November 2006.
[5] Ms Genie Clark served as a Commission Clerk from 29 November 2006 through 12 January 2007.

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GENERAL ASSEMBLY OF NORTH CAROLINA
SESSION 2005

SESSION LAW 2005-442
SENATE BILL 1134

AN ACT TO ESTABLISH THE LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE; TO DIRECT THE COMMISSION TO STUDY ISSUES RELATED TO GLOBAL WARMING, THE EMERGING CARBON ECONOMY, AND WHETHER IT IS APPROPRIATE AND DESIRABLE FOR THE STATE TO ESTABLISH A GLOBAL WARMING POLLUTANT REDUCTION GOAL; AND, IF THE COMMISSION DETERMINES THAT THE ESTABLISHMENT OF A GOAL IS APPROPRIATE AND DESIRABLE, TO AUTHORIZE THE COMMISSION TO DEVELOP A RECOMMENDED GOAL.

The General Assembly of North Carolina enacts:

SECTION 1. Commission Established; Membership. – The Legislative Commission on Global Climate Change is hereby established. The Commission shall consist of 34 members as follows:

(1) Nine members appointed by the President Pro Tempore of the Senate.
(2) Nine members appointed by the Speaker of the House of Representatives.
(3) The President of Duke Power or the President's designee.
(4) The President of Progress Energy or the President's designee.
(5) The President of the North Carolina Citizens for Business and Industry or the President's designee.
(6) The President of the Manufacturers and Chemical Industry Council of North Carolina or the President's designee.
(7) The President of the North Carolina Farm Bureau Federation or the President's designee.
(8) The President of the North Carolina Forestry Association or the President's designee.
(9) The Southeast Regional Director of Environmental Defense or the Regional Director's designee.
(10) The Executive Director of the Southern Alliance for Clean Energy or the Executive Director's designee.
(11) The Executive Director of the North Carolina Coastal Federation or the Executive Director's designee.
(12) The Executive Director of the North Carolina Conservation Council or the Executive Director's designee.

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[6] Mr. Timothy Dodge served as the Commission Analyst from 1 January 2006 through 15 September 2006.
[7] Ms Jessica DiCapua served as the Commission Assistant from 1 January 2007 through 19 January 2007.
[8] Ms Mariah Matheson serves as the Commission Assistant as of 2 February 2007.

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(13) The Dean of the Nicholas School of the Environment and Earth Sciences, Duke University, or the Dean's designee.

(14) The Dean of the College of Agriculture and Life Sciences at North Carolina State University or the Dean's designee.

(15) The Dean of the School of Agriculture and Environmental Sciences at North Carolina Agricultural and Technical State University or the Dean's designee.

(16) The Director of the Carolina Environmental Program at the University of North Carolina at Chapel Hill or the Director's designee.

(17) The Distinguished Research Professor (with expertise in sea level change), Department of Geology at East Carolina University.

(18) The North Carolina State Climatologist.

SECTION 2. Cochairs. – The Commission shall have two cochairs, one designated by the President Pro Tempore of the Senate and one designated by the Speaker of the House of Representatives from among their respective appointees. The Commission shall meet upon the call of the cochairs.

SECTION 3. Quorum. – A quorum of the Commission shall consist of 18 members.

SECTION 4. Vacancies. – Any vacancy on the Commission shall be filled by the original appointing authority.

SECTION 5. Purpose and Duties. – The Commission shall have the following purposes and duties:

(1) The Commission shall conduct an in-depth examination of issues related to global climate change. This examination shall include all of the following:

a. A review of current scientific literature on the possible natural and anthropogenic causes of global climate change.

b. A review of actions taken by the federal government and by other states to address global warming.

c. An examination of the emissions of greenhouse gases from within the State and the extent to which reductions in the emissions of these gases in the State, region, nation, and worldwide could be expected to affect global climate change.

d. An evaluation of the economic opportunities for the State that may result from international, national, and State action to address global climate change and the emerging carbon market.

e. The potential impacts of global climate change on the citizens, natural resources, and economy of the State, including agriculture, travel and tourism, recreation, coastal real estate, insurance, and other economic sectors.

f. The costs of any action taken by the State to address global climate change on individuals, individual households, local governments, businesses, educational institutions, agricultural operations, the State government, and other institutions and economic sectors.

g. The benefits of any action taken by or within the State or other states and at the national or international levels to address global climate change on individuals, individual

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households, local governments, businesses, educational institutions, agricultural operations, the State government, and other institutions and economic sectors.

(2) If, in the course of its examination, the Commission determines that it would be appropriate and desirable for the State to establish a global warming pollutant reduction goal, the Commission may develop a recommended global warming pollutant reduction goal for the State.

(3) In conducting its examination of global climate change, the Commission shall consider and integrate the findings and recommendations of the study of issues related to the development and implementation of standards and plans to control emissions of carbon dioxide required by Section 13 of S.L. 2002-4.

(4) Based on its examination of global climate change, the Commission shall develop findings and recommendations, including any legislative proposals it determines to be appropriate, for consideration by the General Assembly.

SECTION 6. Additional Duties. – The Commission may work cooperatively with other state and national governments to organize a forum on global climate change, including its causes, impacts, challenges, and opportunities in the southeastern United States. The Commission may also work cooperatively with other State agencies with respect to the agencies' areas of responsibilities regarding greenhouse gas emissions and climate change.

SECTION 7. Expenses of Members. – Members of the Commission shall receive per diem, subsistence, and travel allowances in accordance with G.S. 120-3.1, 138-5, or 138-6, as appropriate.

SECTION 8. Staff. – Upon the prior approval of the Legislative Services Commission, the Legislative Services Officer shall assign professional staff to the Commission to aid in its work.

SECTION 9. Consultants. – The Commission may hire consultants to assist with the study as provided in G.S. 120-32.02(b).

SECTION 10. Meetings. – The Commission may meet in the Legislative Building or the Legislative Office Building upon the approval of the Legislative Services Commission.

SECTION 11. Report. – The Commission shall report its findings and recommendations to the General Assembly and the Environmental Review Commission on or before 1 November 2006, at which time the Commission shall terminate.

SECTION 12. Funding. – From funds appropriated to the General Assembly, the Legislative Services Commission shall allocate funds for the purpose of conducting the study provided for in this Part.

SECTION 13. Effective Date. – This act is effective when it becomes law.

In the General Assembly read three times and ratified this the 31st day of August, 2005.

s/ Beverly E. Perdue
President of the Senate

s/ James B. Black

Speaker of the House of Representatives

s/ Michael F. Easley
Governor



Approved 3:15 p.m. this 27th day of September, 2005

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GENERAL ASSEMBLY OF NORTH CAROLINA
SESSION 2005

SESSION LAW 2006-73
SENATE BILL 1591

AN ACT TO EXTEND THE LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE, AS RECOMMENDED BY THE ENVIRONMENTAL REVIEW COMMISSION.

The General Assembly of North Carolina enacts:

SECTION 1. Section 11 of S.L. 2005-442 reads as rewritten:

"**SECTION 11.** ~~Report.~~Reports. – The Commission shall submit an interim report to the General Assembly and the Environmental Review Commission no later than 15 January 2007 and may submit interim reports at other times at its discretion. The Commission shall submit a final report, including any findings and recommendations, ~~report its findings and recommendations~~ to the General Assembly and the Environmental Review Commission on or before ~~1 November 2006,~~15 April 2008, at which time the Commission shall terminate."

SECTION 2. This act is effective when it becomes law.

In the General Assembly read three times and ratified this the 30th day of June, 2006.

s/ Beverly E. Perdue
President of the Senate

s/ Richard T. Morgan
Speaker Pro Tempore of the House of Representatives

s/ Michael F. Easley
Governor

Approved 3:00 p.m. this 10th day of July, 2006

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COMMISSION PROCEEDINGS

FEBRUARY 3, 2006

The Legislative Commission on Global Climate Change convened its first meeting on Friday February 3, 2006 at 10:00 a.m. in Room 643 of the Legislative Office Building.

Representative Joe Hackney, Co-Chair, presided over the meeting. Representative Hackney opened the meeting by introducing Commission staff and Sergeant-at-Arms Staff. Mr. George F. Givens, Commission Counsel, introduced staff counsel, explained the agenda, and reviewed the authorizing legislation that created the Commission. Mr. Givens explained that the major responsibility of the Commission was to determine whether it would be appropriate or desirable for the State to develop a global warming pollutant reduction goal and, if so, to recommend a goal to members of the North Carolina General Assembly.

Dr. William H. Schlesinger, Dean of the Nicholas School of Environmental and Earth Sciences, Duke University and James B. Duke Professor of Biogeochemistry, gave a presentation on the state of the science related to global climate change. His presentation covered carbon dioxide and the atmosphere and its effect on climate and also considered various kinds of effects this may have on the future economics of this State and on the people who live in this State. Dr. Schlesinger asserted that a correlation between carbon dioxide levels and temperature exists and supported the theory that the rise in carbon dioxide levels is due to human activities including fossil fuel combustion and forest destruction. He referenced a statement from the American Geophysical Union, the Nation's premier society of more than 10,000 earth scientists, which says the temperature of the planet is warming and humans are responsible for warming above and beyond any natural variability one may expect. He presented satellite data that showed warming of about two degrees centigrade in the Northern Hemisphere, Alaska, Canada, Northern Europe, and Siberia. He also said that the increase in global surface air temperature is predicted to be between five to nine degrees Fahrenheit by 2060. Dr. Schlesinger discussed the impacts of climate change on sea level rise, the distribution of trees, rainfall patterns, malaria, and hurricane intensity and frequency.
(Pertains to Section 5(1) a and e of the Authorizing Legislation)

Mr. William G. Ross, Jr., Secretary of Environment and Natural Resources (DENR), reported on the ongoing efforts by DENR to control emissions of carbon dioxide and other greenhouse gases. Examples of these efforts include the North Carolina Clean Smokestacks Act (CSA), which established a plan and deadlines for significant reduction of sulfur dioxides, nitrogen oxides, and mercury. The Division of Air Quality (DAQ) within DENR also conducted a study on carbon dioxide emissions that evaluated the science of climate change and options for reducing greenhouse gas emissions. DENR extended their technical efforts by forming the Climate Action Plan Advisory Group (CAPAG), which was established to conduct a facilitated dialogue with a diverse group of parties who were interested in the subject of climate change. Secretary Ross

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highlighted the partnership between North Carolina and the military, which focused on sustainability of environmental, social, economic, and military on an ongoing basis and also the efforts by the Commonwealth of Pennsylvania to bring in a Spanish wind energy company and create jobs. Secretary Ross concluded by saying that DENR and DAQ wanted to provide the tools and the ability to analyze, on a cost benefit basis, the steps that our State might take to prepare for global climate change.
(Pertains to Section 5(1) b of the Authorizing Legislation)

Mr. Brock Nicholson, Deputy Director, Division of Air Quality, Department of Environment and Natural Resources, gave the final report on issues related to the development and implementation of standards and plans to implement programs to control emissions of carbon dioxide from coal-fired generating units and other stationary sources of air pollution. Mr. Nicholson focused his talk on recommendations from the final report on Carbon Dioxide Emissions Reduction Strategies for North Carolina. The recommendations from the report fall into three groups: (1) actions that are currently underway and consist of eight listed plans of action; (2) group of regulations that may not require legislation and; (3) group of recommendations that requires some other direction by entities such as the Commission and the Legislature. Examples of these carbon dioxide reduction recommendations include getting the North Carolina State government to increase its leadership role and intensify efforts outlined in State Energy Plan and to develop a renewable portfolio standard. Mr. Nicholson said that the next steps are to establish the Climate Action Plan membership in groups, implementation of inventory details, and to work with this Commission to develop the climate action plan advisory group (CAPAG), report to this Commission, the General Assembly, and the Governor and to implement these recommendations. Mr. Nicholson also gave a report on specific activities and plans of DAQ, DENR, to develop and implement standards and plans to control emissions of carbon dioxide and other greenhouse gases.
(Pertains to Section 5(1) d of the Authorizing Legislation)

Ms Judith Greenwald, Director of Innovative Solutions, Pew Center on Global Climate Change, Alexandria, Virginia, presented a report on actions taken by other states and local governmental units in the United States to address global climate change. Specifically, she discussed actions being taken in New York, California, Pennsylvania, and in the Southwest. Ms Greenwald said that most states are involved in some sort of regional initiative on either climate change or clean energy: 28 states have climate action plans, a number of states have greenhouse gas reporting, 22 states and the District of Columbia have renewable portfolio standards, 27 states have incentives and mandates for promoting ethanol, a lot of states have worked together to track renewable energy credits across state lines, and 10 states have formally adopted the California greenhouse gas standards. Ms Greenwald also asserted that North Carolina state emissions were significant with electricity and transportation sectors are the biggest emitters.
(Pertains to Section 5(1) b of the Authorizing Legislation)

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Representative Hackney called on Mr. Jim Havens to bring the Commission up to date on what he was doing regarding greenhouse gas emissions. Representative Hackney then asked members to comment on future speakers, topics, and their ideas for direction of the Commission.

The meeting was adjourned at 3:00 p.m.

MARCH 7, 2006

The Legislative Commission on Global Climate Change convened its second meeting on Tuesday March 7, 2006 at 10:00 a.m. in Room 643 of the Legislative Office Building with Mr. John Garrou, Co-Chair, presiding. George Givens, Commission Counsel, reviewed the agenda items for the day's meeting.

Dr. Robert Balling, from Arizona State University presented on the state of the science related to global climate change. He asserted that there was no doubt in the scientific community that the earth's temperature is rising, that an anthropogenic signal exists. He then talked about the geological temperature record and addressed the effects of climate change on hurricanes and sea levels. Dr. Balling said that there was no evidence about what will happen to the intensity and frequency of tropical storms as a result of climate change. Although he agreed that sea levels are rising, he pointed out that they have been rising for the last 8000 years. He concluded by saying that he is skeptical that much could be done in North Carolina to impact the carbon dioxide levels of the atmosphere.
(Pertains to Sections 5(1) a, c, and e of the Authorizing Legislation)

Dr. Stanley Riggs is a member of the Commission and Distinguished Research Professor in the Department of Geology at East Carolina University. He discussed climate and sea level change, storm and coastal dynamics, beach erosion, and shorelines changes with a particular focus in North Carolina. He asserted that the impact of climate change could be very dramatic, particularly in eastern North Carolina where elevation in some counties is only a foot or two above sea level. Sea levels are rising 1.5 feet per century and are predicted to rise to 3 feet per century, which could cause North Carolina to lose as much as thirty to forty percent of its Coastal Plain leading to significant loss of land and significant economic loss. He discussed beach, marsh, and wetland erosion in the state: North Carolina's beaches are eroding in response to rising sea level that averages from three to fifteen feet per year. With regard to tropical storms, Dr. Riggs pointed out that between 1993 and 2005, mid-Atlantic coastal areas experienced the highest tropical storm activity in recorded history.
(Pertains to Sections 5(1) e and f of the Authorizing Legislation)

Dr. Robert Jackson is a Professor of Biology and Professor of Environmental Science at the Nicholas School of the Environments Earth Science at Duke. He directs the Center on Global Change and the new Department of Energy called Southeastern Regional National Institute for Climate Change Research. He discussed the direct link between human activity and greenhouse gases on the earth's rising temperature. Dr. Jackson pointed out

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that the Intergovernmental Panel on Climate Change (IPCC), the American Geophysical Union, the National Academy of Sciences, and the American Association for the Advancement of Science all agree that there is a direct link between human activity, greenhouse gases, and warming of the earth. Dr. Jackson provided data, graphs, and references to support his assertions. The graphs illustrated that greenhouse gases and temperature were rising and suggested a correlation between the two. He asserted that in order to stabilize carbon dioxide levels, carbon dioxide emissions would have to be reduced dramatically.
(Pertains to Sections 5(1) a and c of the Authorizing Legislation)

Dr. Sethu Raman, a member of the Commission is also the State Climatologist. Dr. Raman is a Professor of Meteorology in the Department of Marine, Earth, and Atmospheric Sciences at North Carolina State University. His presentation focused mostly on temperature and precipitation trends in North Carolina. Dr. Raman provided the history of the State Climate Office in North Carolina, in addition to its mission and involvement in various projects. The State Climate Office's mission is to provide the most accurate climate information to the citizens of North Carolina and assist North Carolina State agencies in climate, environmental issues, and other obligations. His presentation addressed the regional and local change in the climate in North Carolina. He presented results on short and long terms climate trends in the State. Based on the data that has been collected, short term trends indicate warming along the coast, cooling in central North Carolina, a deficit in precipitation in the northern coastal part of North Carolina, and in increase in precipitation in the southern part of North Carolina. Dr. Raman asserted that the density of climate observations needed to be improved in order to be confident about observed trends.
(Pertains to Section 5(1) a of the Authorizing Legislation)

Brock Nicholson from the Climate Action Plan Advisory Group (CAPAG) of DENR gave a quick review of the CAPAG, Climate Action Plan Work Group Process. He stated the purpose of CAPAG was to develop climate action plan recommendations and that they intended to look at and quantify the costs and benefits of the proposed or recommended actions. He discussed the CAPAG's first "get together" meeting: they covered the findings and recommendations of the Clean Smokestack's Act report; talked about the process that is occurring by the body, reviewed some of the history of state climate actions around the country, discussed emissions inventory, and formed technical working groups. Mr. Nicholson discussed the verbal suggestions from the first CAPAG meeting with the Commission.
(Pertains to Section 5(1) b, f and g of the Authorizing Legislation)

The meeting was adjourned at 3:30 pm by Co-chair John Garrou.

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APRIL 4, 2006

The Legislative Commission on Global Climate Change convened its third meeting on Tuesday April 4, 2006 at 10:00 a.m. in Room 544 of the Legislative Office Building with Representative Joe Hackney, Co-Chair, presiding. George Givens, Commission Counsel, reviewed the agenda items for the day's meeting.

Mr. B. Keith Overcash, Director, Division of Air Quality, DENR, provided an update on activities of the DENR and the Climate Action Plan Advisory Group (CAPAG). At CAPAG's first meeting on February 16, 2006 ground rules were set and working groups were established. Discussions included conducting a greenhouse gas inventory in North Carolina and members were asked their thoughts on how the process should work and where they thought we should end up in the process. They plan to produce a final report and recommendations to the Environmental Review Commission (ERC) and the Environmental Management Commission (EMC) around April 2007.

Mr. David R. Easterling, Chief, Scientific Services Division, National Climatic Data Center, National Oceanic and Atmospheric Administration (NOAA), Asheville, North Carolina, was the first speaker on the state of the science related to global climate change. He provided evidence showing how the climate has changed over the last 100 years and showed examples of observed climate change. Temperature data indicates that global temperatures have risen approximately 0.7 percent centigrade since the 1800's. Although it is unclear if global warming is a contributor, global precipitation appears to have increased since the late 1800's. Hurricanes have increased with oscillations in ocean temperatures, sea ice has decreased, snow cover has decreased, and changes in the number of frost days and days exceeding other thresholds. All of these examples point to warming. Mr. Easterling also discussed climate models and some of the results they have produced; in addition to pointing that out clouds are sources of the largest uncertainties in climate models.
(Pertains to Section 5(1) a and e of the Authorizing Legislation)

Patrick J. Michaels, Ph.D., Research Professor and State Climatologist, Virginia State Climatology Office, University of Virginia, Charlottesville, Virginia, presented his view of the state of the science related to global climate change data. He asserted that there is bias and polarization on climate change that is presented to the public. Dr. Michaels presented some global warming and cooling data and information on hurricanes. His solution to the questions on global warming is that Kyoto is expensive and causes long-term economic problems. Dr. Michaels advocated for encouraging global economic development and adaptation to climate change, rather than prevention of climate change. He believes money is better spent adapting to the changes caused by climate change rather than preventing climate change.
(Pertains to Section 5(1) d and f of the Authorizing Legislation)

William L. Chameides, Ph.D., Chief Scientist, Environmental Defense, New York, gave a presentation on the state of the science related to global climate change. He supported the view that the increase in carbon dioxide is caused by human activity and that the earth

is warming. He asserted that a temperature increase of two degrees centigrade is likely to be the tipping point (i.e. an irreversible point where it will be impossible for the climate system to recover) for loss of the Greenland ice sheet, loss of the Amazon tropical rainforest, and the melting of permafrost and release of greenhouse gases from the permafrost. Dr. Chameides believed that in order to avoid this 2 degrees centigrade temperature increase, emissions need to be stabilized globally and the United States must cap greenhouse gas emissions at about 10 percent of current levels. He promoted a market based cap and trade program and referenced a paper by Pacala and Socolow that lists 15 existing technologies that could help decrease emissions by 40 to 60 percent of current levels.
(Pertains to Section 5(1) a, b, c, d, e, and f of the Authorizing Legislation)

Michael MacCracken, Ph.D., Chief Scientist for Climate Change Programs, Climate Institute, Washington, D.C. gave his presentation on understanding and projecting climate change. He discussed the impacts and potential impacts of climate change. First he discussed the efforts made in California and New York. Then Dr. MacCracken showed highlights of a study that looked at the consequences, both good and bad, of reducing fossil fuel consumption in the southeastern United States. Key issues that came up for the southeast regional assessment were what it would do to agriculture, forests, water quality, air quality, and extreme events. Dr. MacCracken also discussed coastal issues, coral reefs, ecosystems, water distribution, health effects, and the potential impacts on infrastructure.
(Pertains to Section 5(1) a, b, and e of the Authorizing Legislation)

Mr. Truman T. Semans, Director for Markets and Business Strategy, Pew Center for Global Climate Change, Washington, DC, was the first of four speakers to report on activities taken by businesses in the State and nationwide to address global climate change. Mr. Semans explained how climate and energy fit into corporate business strategies including reducing greenhouse gas emissions; capturing competitive advantage in a business opportunity associated with climate change; and constructive, external engagement. Mr. Semans concluded by saying that there are two broad approaches a company can take to reduce greenhouse gas emissions—(1) promote energy efficiency and reduce greenhouse gas emissions from operations , (2) reduce the broad footprint of the products and services that a company makes.
(Pertains to Section 5(1) f and g of the Authorizing Legislation)

Mr. Tom Darden, Chief Executive Officer, Cherokee Investment Partners, Raleigh, North Carolina, spoke about Cherokee Investments's efforts to address global climate change. Cherokee's primary role is to treat fuel contaminated soil, mostly with bacteria by remediation. Cherokee also tries to have some input into what is built on the sites they clean up.
(Pertains to Section 5(1) g of the Authorizing Legislation)

Mr. Robert L. Kee, Senior Vice President, Document Management, Bank of America (BOA), Charlotte, North Carolina, gave his and Bank of America's views on the issue of global climate change. He pointed out that BOA is committed to the long-term

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sustainability of their business and that of the communities they serve. He listed many actions BOA is taking to address sustainability including: setting a goal to reduce paper consumption by 25 percent over three years: setting a voluntary goal with the EPA to reduce greenhouse gases by 9 percent by 2009 (based on a 2004 benchmark); and launching the Electronification of Paper Program.
(Pertains to Section 5(1) f and g of the Authorizing Legislation)

Mr. William F. Bailey, Principal Consultant, DuPont, Charlotte, North Carolina, gave a presentation on DuPont's activities with regard to addressing global climate change. Mr. Bailey said that the challenge for DuPont is to address issues such as climate change in a way that makes business sense, upholds its core values, and sustainable growth. Mr. Bailey discussed some of the measures DuPont had undertaken to address climate change. DuPont committed to reduce their greenhouse gas emissions by 65 percent versus a 1990 baseline, hold total energy use, flat, versus a 1990 baseline, and supply 10 percent of their total energy needs from renewable resources at a cost, competitive with the best fossil-derived alternatives. DuPont also provides a broad array of enabling technologies, such as making bio-fuels and bio-based raw materials, which can help their customers reduce their greenhouse gas emissions footprint.
(Pertains to Section 5(1) f and g of the Authorizing Legislation)

The meeting was adjourned at 4:11 p.m.

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APRIL 25, 2006

The Legislative Commission on Global Climate Change convened its fourth meeting on Tuesday April 25, 2006 at 10:00 a.m. in Room 643 of the Legislative Office Building with Mr. John Garrou, Co-Chair, presiding. George Givens, Commission Counsel, reviewed the agenda items for the day's meeting.

Dr. David Green, Corporate Fellow from the Oak Ridge National Laboratory in Knoxville, Tennessee discussed the transportation sector. The transportation sector is second to industry in greenhouse gas emissions and the largest carbon dioxide emitter. He argued that by using a mix of policy and economic measures, regulatory, and other measures that greenhouse gas emissions from the United States transportation sector could be reduced by 20 to 25 percent by 2015 and by as much as half by 2030. Dr. Green discussed, in detail, many of the potential policy and economic measures including moving people to mass transit, increasing fuel economy via technology and policy, and using alternative fuels. He also addressed how state policies differ from national policies. *(Pertains to Section 5(1) d, f, and g of the Authorizing Legislation)*

Dr. Edward Rubin is from the Center for Energy and Environmental Studies in the Department of Engineering and Public Policy at Carnegie-Mellon University. Dr. Rubin discussed greenhouse gas reductions from the electric power sector, options that are available to reduce power sector emissions of greenhouse gases, and some key policy considerations. He pointed out that power plants are a large source of carbon dioxide and that coal-fired power plants are major national and local considerations. Some of the potential options available for reducing carbon dioxide emissions in the power sector include: reducing demand; improving efficiencies in technologies used for power generation, transmission, and distribution; utilizing power generation technologies that use no or low carbon; and employing technologies that might be able to both capture and store or sequester carbon dioxide. Dr. Rubin also discussed regulatory policies that would help limit greenhouse gas emissions.
(Pertains to Section 5(1) d, f, and g of the Authorizing Legislation)

Dr. Marilyn Brown, Interim Director of the Engineering Science and Technology Division of Oak Ridge National Laboratory in Oak Ridge, Tennessee discussed opportunities to reduce greenhouse gas emissions from the built environment. She first asserted that residential, commercial, and industrial buildings account for 43 percent of United State's carbon dioxide emissions. Some of her suggestions for reducing greenhouse gas emissions from the built environment include: improving efficiency, installing electric chromic windows and unconventional water heaters, and preserving land in farm and forest use, to name a few. Dr. Brown discussed the Energy Policy Act, which was put in place because of policies needed to simulate investments. She claimed that the Energy Policy Act was not sufficient to meet challenges; in particular one flaw is that it does not have mandatory regulations. She promoted Leadership in Energy and Environmental Design (LEED) certification, energy efficiency resource standards, and smart growth. In the long term, Dr. Brown was optimistic for zero energy buildings. She asserted that greenhouse gas emissions in the building sector could be decreased to

today's levels by 2025 if all of the technological opportunities are totaled and the policies investigated in the Pew report are itemized. This would amount to a 10 percent overall reduction in the nation's greenhouse gas emissions in 2025.
(Pertains to Section 5(1) a, b, c, f, and g of the Authorizing Legislation)

Dr. Dennis W. Hazel, a Professor in the Forestry and Environmental Outreach Program at North Carolina State University, discussed the range of opportunities represented by the forestry and agricultural sectors to address climate change. Forestry is the second largest industry in North Carolina and a 29 billion dollar per year economic additive. Dr. Hazel discussed four ways that forestry and agriculture can contribute solutions to the global climate change issue including reducing carbon dioxide, methane, and nitrous oxide emissions; promoting carbon sequestration perhaps by increasing land area; improving the productivity of the land in order to improve carbon sequestration; and substituting farm and forest biomaterials for others. He also provided a list of possible action items including: protecting farmland from permanent conversions; improving feed efficiency; increased use of residential and urban trees; and dedicated crops for ethanol. Dr. Hazel pointed out many economic opportunities for North Carolina, such as the biomass industry and waste salvage.
(Pertains to Section 5(1) d, f, and g of the Authorizing Legislation)

Brock Nicholson, Deputy Director of the Division of Air Quality, presented an update on the activities of the Climate Action Plan Advisory Group (CAPAG). He focused mainly on an update on the activities of the Technical Work Groups; the five work groups include agriculture and forestry, energy supply, energy use by residential, commercial, and industrial, transportation, and land use. Mr. Nicholson announced that the CAPAG planned to finish its work by the summer of 2007.

Dr. Karl Hausker, who works for Center for Climate Strategies (CCS), discussed the CAPAG process and discussed each mitigation option. Dr. Hausker explained that the CCS has a catalog of options that other states are either considering or implemented. Many options are presented to CAPAG, with initial information on the potential greenhouse gas emission reductions that may result, estimated a cost-per-ton for reducing emissions, and potential impacts on air quality, water quality, energy security, economic development, etc. This information helps CAPAG screen which options to focus on. A subset of 40 to 60 options are selected and work groups conduct a detailed examination on the options. The work groups develop recommendations and analytical support for the options. Finally, this information is presented to CAPAG for consideration and ultimate recommendation in their final report.

Joseph E. Aldy, a Fellow with Resources for the Future, discussed the primary determinants of mitigation costs and the issues to consider in order to project how the economy, individuals, and firms respond to a climate change policy in order to reduce their emissions of greenhouse gases. Mr. Aldy discussed determinants of mitigation costs, opportunities for investing in more energy efficient technology, and cost implications of policy design. He also explained how one might address uncertainty and risk when designing climate change policy. Mr. Aldy presented examples of successful cap and

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trade programs, such as the acid rain program. He also discussed different kinds of cap and trade programs and other policy options in the United States and Europe, ranging from moderate to stringent reductions in carbon dioxide, and how they would impact the economy. Finally, Mr. Aldy highlighted ancillary benefits that would likely result from addressing climate change, such as improved air quality and reduced congestion and traffic accidents.
(Pertains to Section 5(1) b, d, f, and g of the Authorizing Legislation)

Margo Thorning, Vice-President and Chief Economist of the American Council for Capital Formation, explained what some of the models have shown in terms of cost of trying near term of emission reductions. In addition she discussed what is going on in Europe and how their system is working. Specifically, Ms. Thorning looked at how the European Union is conducting their emissions trading system. Ms. Thorning discouraged the use of a cap and trade program in North Carolina and encouraged that a cost-benefit analysis be conducted before adopting any mandatory policies or further policies to address greenhouse gas emission reduction. She asserted that it is essential that research and development be increased. Ms. Thorning also discussed what other countries, such as China and India, are doing to address climate change.
(Pertains to Section 5(1) b, d, f, and g of the Authorizing Legislation)

Dr. John C. Whitehead, Associate Professor at the Department of Economics at Appalachian State University talked about what the cost might be if climate change is not mitigated. Dr. Whitehead estimated the damages to North Carolina based on an annual one percent change, which could be the lowest amount of damages North Carolina may face; the total is 34 million dollars in health impacts and 17 million dollars in environmental impacts. This is approximately 50 million dollars in total damages, which is about 0.2 percent of State personal income and approximately 16 dollars per North Carolina household. He estimated the costs to human health including heat and storm related deaths, non-melanoma skin cancers, and drinking water contamination. He also estimated costs associated with damaged wetlands, beach erosion, commercial fishing, hurricane damage, and increased probability of extinction for coastal threatened and endangered species.
(Pertains to Section 5(1) e, f, and g of the Authorizing Legislation)

George Givens informed the Commission that the next meeting will not occur until after the legislative session, i.e. in August or September. He welcomed input on how the Commission should proceed once meetings resume.

The meeting was adjourned at 4:19 pm by Co-chair John Garrou.

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OCTOBER 3, 2006

The Legislative Commission on Global Climate Change convened on Tuesday October 3, 2006 at 10:00 a.m. in Room 643 of the Legislative Office Building.

Co-chairs John Garrou and Representative Joe Hackney called the meeting to order and welcomed all committee members. George Givens, Commission Counsel, reviewed the agenda items for the day's meeting.

Joshua Bushinsky, State Solutions Fellow from the Pew Center on Global Climate Change, presented a report on actions taken or under consideration by other states to address global climate change. He summarized the variety of reasons for which states are taking action on climate change, including concerns about changes in weather patterns causing droughts, intense and frequent storms, and negative impacts on economic development. States are also pursuing the positive effects on economic development that can be achieved by getting ahead of the regulatory curve. There are currently twelve states with targets for reducing greenhouse gas emissions. Those include the states involved in Regional Greenhouse Gas Initiative, California, and Arizona. Twenty-two states as well as the District of Colombia have renewable portfolio standards, and ten states over the past six months have adopted either standards or incentives for renewable fuels. States set targets for reduction according to what is achievable, using strategies that have been adopted elsewhere, using current and available technologies, and remaining in line with what scientists believe is necessary to avoid dangerous climactic change. *(Pertains to Sections 5(1) b and e of the Authorizing Legislation)*

James Kerr II, Commissioner of the North Carolina Utilities Commission, presented an update on the North Carolina Utilities Commission study on a Renewable Energy Portfolio Standard (REPS), which would mandate that a certain percentage of electricity come from renewable sources. The Renewable Portfolio Standards Advisory Group (RPSAG) was created to discern the impact of a REPS on electric rates as well as the impact on North Carolina's entire economy, including the potential for job creation and the offsetting of negative impacts on industrial rates. In addition to renewables, the Commission and the Advisory Group will examine methods for energy efficiency that will also lessen the reliance on traditional energy sources. The final report will be released for comment when the General Assembly convenes in January 2007. *(Pertains to Section 5(1) b, d, and g of the Authorizing Legislation)*

Robert Gruber, Executive Director of the Public Staff for the North Carolina Utilities Commission, presented a report on the proposal of the Public Staff of the North Carolina Utilities Commission to create a public benefits fund. An increased focus on Demand Side Management (DSM) programs and renewable energy in 2005 and 2006 led the Commission to hold several public hearings. During these hearings, participants commented that utilities have a disincentive to develop and implement DSM programs. Having an independent, non-utility third party administer the DSM programs, as occurs in Vermont and Wisconsin, prevents the need for special rate treatments to address the problem of lost revenue. Ultimately, DSM programs require an effort both on the part of

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utilities to spend money on the programs, and on the part of the consumer to make changes in behavior.
(Pertains to Section 5(1) b, d, and g of the Authorizing Legislation)

Brock Nicholson, Deputy Director of the Division of Air Quality in the Department of Environment and Natural Resources, Mitch Peele, Tim Toben, George Everett, Michael Shore, Stephen Smith, and Tom Peterson presented an update on the activities of the Climate Action Plan Advisory Group (CAPAG). The CAPAG has adopted a rigorous approach to choosing strategies and low-hanging fruit for mitigation options for reducing greenhouse gases in North Carolina. After considering a wide range of options, they selected 52 to look further into and examine with a more intensive cost-benefit analysis. Options were selected according to the potential emission reductions compared to the cost of implementation. Some viable options currently on the table include an environmental portfolio strategy, which 22 states have implemented. Others include building codes to improve energy efficiency, combined heat and power systems, Integrated Gasification Combined Cycle (IGCC) plants, and tax credits for biofuels. In North Carolina's agriculture and forestry sectors, there are many opportunities for programs to both provide incentives to keep land in forests and agriculture and provide greenhouse gas offsets. These should be the areas that North Carolina has the most to gain from in mitigation scenarios.
(Pertains to Section 5(1) d and g of the Authorizing Legislation)

The meeting closed with discussion and announcements for the next meeting and was adjourned by Representative Hackney at 3:10 p.m.

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NOVEMBER 27, 2006

The Legislative Commission on Global Climate Change convened on Monday November 27th, 2006 at 10:00 a.m. in Room 643 of the Legislative Office Building.

Mr. John Garrou, Co-Chair, presided over the meeting. Mr. Garrou called the meeting to order and called on George Givens, Commission Counsel, reviewed the agenda items for the day's meeting.

Brock M. Nicholson, Deputy Director of the Division of Air Quality in the Department of Environment and Natural Resources, gave an update on the activities of the Climate Action Plan Advisory Group (CAPAG) from its October 12, 2006 meeting.
The primary objective of is CAPAG meeting was to define the options and recommendations. One issue that received a lot of focus was that of adaptation, (which will be a focus of an upcoming Commission meeting), and recommendations surrounding adaptation will be recommendations and win-wins in the near-term. The list of high priority issues includes the cost and benefits of job creation in various sectors and the economic benefits to the State in a number of sectors that new industry and innovation from mitigating climate change can bring. The next CAPAG meeting is scheduled for January 24, 2007. The CAPAG is considering the possibility of extending their timeline to better coordinate with the Commission's schedule, as they provide the Commission with recommendations and support and more in-depth studies of the important topics.

Franz Litz, the Climate Change Policy Coordinator in the New York State Department of Environmental Conservation, presented on the development of the Regional Greenhouse Gas Initiative (RGGI) in the Northeast. Mr. Litz emphasized the use of research and regionally relevant studies in order to better understand how climate change will affect each state and its constituents specifically. RGGI is the first mandatory cap and trade program for carbon dioxide and power plants. In a cap and trade program, the total emissions from a defined source are determined and a cap on emissions is established. Permits are issued per ton up to the limit of the cap, and each source of the pollutant has an emissions and allowance account. The source can reduce its emissions through actual emissions reductions or by buying permits to cover the emissions, whichever option costs less. RGGI's target for the emissions reductions in the first five years is to cap emissions at current levels and then to reduce emissions by 10 percent over the next four years. This program also incorporates offsets, where emissions sources are allowed to purchase certified reductions outside of the covered sectors. The credits from these purchases can be used interchangeably with the allowances/permits. The five initial types of offsets permitted in RGGI include: natural gas, propane or heating oil efficiency; converting land to forest and proving a reduction; capturing gas from landfills and using in combustion; methane capture from animal operations, an offset to benefit the electricity sector. New offsets are allowed in the program in order reduce the price pressure of the program. The offset program encourages regional and often in-state investment. As a region, the Northeast offers great potential to make reversing climate change a real issue and to make meaningful strides, more so then if it was a single state initiative. RGGI is continually

trying to work with other states and other markets, such as California, as they have found that linking states together leads to a more cost effective program.
(Pertains to Section 5(1) b of the Authorizing Legislation)

Kurt Creamer, the Biomass Program Manager at North Carolina Solar Center and Animal and Poultry and Waste Management Center at North Carolina State University, gave a presentation on the options for production and use of biofuels in North Carolina. Biofuels offer many potential benefits to North Carolina including reducing tail pipe emissions and greenhouse gas emissions, generating jobs at fuel production plants, and increasing energy security. The most promising energy crops, either currently grown in North Carolina, existing naturally, or easily implemented in growing cycles include: canola for biodiesel; switchgrass for ethanol to be used in coal firing, combustion and gasification to generate electricity; hulless barley for starch based ethanol plants; coastal bermudagrass, which is already planted in spray fields for its tremendous nutrient uptake potential; and woody biomass because of the expanse of forest in North Carolina. One product with much potential but little scientific research as of yet, is the use of microalgae as a biofuel, though preliminary studies have shown that it produces up to 5,000 to 15,000 gallons of biofuel per year.

The most commonly used type of biofuel is ethanol, which can be produced from sugar crops, including sugar cane, sugar beets, or sweet sorghum, or from corn. In the United States, ethanol is primarily produced from corn. In 2006 up to 20 percent of the nation's corn crop went into ethanol production. Ethanol use in North Carolina is at about 5 million gallons per year, and though there are currently no ethanol production plants in the State, three have been proposed. Biodiesel is produced by a chemical reaction between methanol and a source of oil and fat such as canola oil, soybeans, peanuts, cotton seed, and rendering operations that provide animal fats. Hog waste and poultry litter also present opportunities to capture methane and eliminate the greenhouse gas source and generate electricity. The energy balance of biofuels, the amount of energy inherent in the fuel divided by the amount of energy required to produce it, is best for cellulosic ethanols such as sugarcanes, sugar beet, and switchgrass.

Moving ahead with these findings, the Biomass Council is working to create a road map for the State in terms of biomass for power production and biofuel production. Funding to promote biofuels across the State can be found in several federal programs that promote the use of renewable energy and several State tax credit programs specifically for the production and distribution of biofuels. However, farmers face a great risk in undertaking this type of project and are not willing to pay the up front costs of conducting feasibility studies. These costs are not accounted for in federal or state programs and present a real barrier to more widespread implementation of biofuel crops and production.
(Pertains to Section 5(1) d and g of the Authorizing Legislation)

Tim Toben, a member Commission and the Chief Executive Officer of Carolina Green Energy Corporation presented an overview of two recent reports on the economic impacts of climate change.

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The first report Mr. Toben reviewed was The Stern Review Report on the Economics of Climate Change, produced in Great Britain by Sir Nicholas Stern, the Head of Government Economic Services. The study was based on data from the Hadley Center in the United Kingdom, the Energy Forum, the United States Climate Change Science Program, and the Intergovernmental Panel on Climate Change. The conclusions of the report are that the world faces tremendous costs from climate change by delaying action, close to losing five percent of the global Gross Domestic Product (GDP), and that mitigating climate change now is less than 1 percent of the global GDP. Some of the findings include: a decline in crop yields and food shortages; water shortages and flooding; not reducing now would result in double the concentrations of greenhouse gas by 2035 from the pre-industrial level; the benefits in shifting the world to a low carbon path now would be on the order of 2.5 trillion dollars. The report listed several recommendations, including the fact that acting now still offers the potential to avoid the worst impacts of climate change. Moving ahead with actions should include: forming collaborative partnerships among governments, business and individuals; creating effective policy at the state and national level; stabilize energy levels emissions over the next 20 years and between 1 and 3 percent after that; trade agreements to detect the effectiveness of investment and innovation globally; reduce deforestation; and integrating climate change into development policies. The report also emphasized carbon pricing, taxation, emissions trading or regulation, and technology policy as driving the development and large scale deployment of low carbon and high efficiency products, promotion of energy efficiency, removal of barriers to energy efficiency.

The second report, Mr. Toben reviewed was Impacts on U.S. Energy Expenditures of Increasing Renewable Energy Use, by the RAND Corporation. This report lays out the results of a modeling scenario where the United States incorporates 25 percent renewable energy sources into its energy mix by 2025. The study was built on data from energy demand and supply projections from the U.S. Energy Information Administration. Results and recommendations are based on the analysis of 1500 test runs that varied future costs and rates of technology changes for fossil fuels and renewable energy. What the RAND Corporation found is that when renewable energy is at 25 percent of the total energy mix, the total energy expenditures were lower in nearly all cases, where current energy price and cost trends were business as usual. Additionally, as long as renewable technology continues to improve at least 20 percent in the next 20 years, renewables could produce 25 percent of U.S. electric power and 10 percent of motor vehicle fuels by 2025 with no additional costs to the economy. Some of the positive effects of incorporating 25 percent renewables into our energy mix include: a 2.5 million barrel per day cut in U.S. petroleum consumption, or about 10 percent of projected U.S. consumption; the elimination of one giga ton of carbon dioxide emissions, resulting in a 50 percent reduction in U.S. contributions to global warming and a reduction in air pollution; and an increase in jobs and economic growth in rural communities. Still, there are several challenges to using renewables such as intermittency, transmission, interconnection, supply, as well as the costs, which are expected to decline by 45 percent in the next 20 years.

(Pertains to Section 5(1) a, c, and e from the Authorizing Legislation)

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The meeting was adjourned by Mr. John Garrou at 1:15 pm.

DECEMBER 11, 2006

The Legislative Commission on Global Climate Change convened on Monday December 11, 2006 at 10:00 a.m. in Room 643 of the Legislative Office Building.

Representative Joe Hackney, Co-Chair, presided over the meeting. Representative Hackney called the meeting to order and explained the agenda. George Givens, Commission Counsel, reviewed the agenda items for the day's meeting. He informed the committee of upcoming meetings of the Environmental Review Commission and the North Carolina Utilities Commission both including items on their agendas that might be of interest to this commission.

The Honorable Richard H. Moore, North Carolina's State Treasurer, present on the investment policy of North Carolina as it relates to global climate change. Treasurer Moore is the sole fiduciary of the State's public pension funds, over $70 billion in assets, which he invests on behalf of the State. The investment strategy usually is as such: 58 percent in public equities, 35 percent in fixed income, and less than 5 percent in real estate and alternatives. Because of the amount of money which North Carolina has invested in public equities, good corporate governance and transparency in publicly traded companies is extremely important. One area in particular which the North Carolina Treasurer's office has focused on within corporate governance and transparency, is the issue of global warming, specifically carbon emissions. If the company that the Treasurer's office has bought stock in is, for example, an insurance or an oil and gas company, they want to know if they are properly valuing their liabilities. If not, then the company is not being run in a responsible way, a way to reward the ultimate long term share holders or public pension funds. Mr. Moore pointed out that though the shareholder has no say in the day-to-day running of a company, they do by extension, through the Board of Directors, whose job it is to run the company. The shareholders and money managers thus have the right and responsibility to ask questions and expect answers of the companies. They have a responsibility to challenge companies about their environmental impacts.
(Pertains to Section 5(1) d from the Authorizing Legislation)

Dr. Michael Walsh, the Senior Vice President of the Chicago Climate Exchange (CCX), presented on the Exchange's greenhouse gas emission registry and reduction and trading system, and the potential benefits to North Carolina. The CCX is one of two cap and trade emissions markets in the world, the other being the European Union. The CCX includes about 250 million metric tons of carbon dioxide equivalent emissions in their cap and trade system. It is a voluntary program with no regulatory authority. Members sign a contract and are legally committed to emissions reductions schedules which are created during the negotiations process. The exchange has about 225 members including industries, universities, farmers, governments, smaller business, and non-governmental organizations (NGOs). The exchange began with a four year commitment to cut

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emissions by 1 percent per year, in order to get to 4 percent below the baseline by 2006. The baseline in this case is the average of the emissions included during the years 1998 through 2001. All members of CCX have to include their major emitting activities in the U.S., with entity wide participation. Members must also quantify emissions and conduct an audit, in order to establish a baseline. Then they are given a batch of tradable permits and extra tradable allowances, which can be banked and used in later years. If a member does not meet their budgeted amount of emissions reductions, they have to buy credits from another member, perhaps one with an extra cut from an offset project. All members are audited each spring. The CCX is a fully integrated and electronic environmental audit and trading system. The first concept in selecting offsets is to bring in reductions from low-cost sectors and to provide economic development opportunities to those areas that need to be built out. The CCX has an open door policy for anyone willing to be audited and make the commitment.
(Pertains to Section 5(1) b and g of the Authorizing Legislation)

Thomas R. Casten, founder and chair of the Alliance for Clean Technology and founder and former Chief Executive Officer of Trigen Energy and Primary Energy Ventures, led a discussion on combined heat and power as a method for reducing greenhouse gas emissions and increasing energy efficiency. The Alliance for Clean Technology is a coalition of local power developers, World Wildlife Fund, Greenpeace, the Sierra Club, the Suzuki Foundation, and other environmental groups, union workers concerned about the loss of jobs, and gas and electric distribution utilities. The mission of the Alliance is to promote clean technology policies to reduce greenhouse gas emissions, to boost the economy, and to buy time for new technologies to improve. Clean technology options which hold great promise include energy recycling, for example combined heat and power. Capturing the exhaust heat from power generation or industrial waste that industries normally throw away, has the potential to generate 20 percent of the United States' electricity.

Combined heat and power systems are not more widely used in the United States because industries interested in implementing them face regulatory barriers and interconnection costs and are denied payment for benefits that can be provided such as cleaner technology. This is primarily because the energy generation system has not been updated in several decades. In the United States, 38 percent of carbon emissions come from electricity generation, whose efficiency peaked 45 years ago. With the system as it is now, electricity received by the end user represents one third of the fuel used to generate it. Combined heat and power plants increase efficiency by up to 50 percent, as they are located on-site and the fuel used to make power results in thermal heat which can be used and distributed. Local generation reduces the need for a central grid and power does not travel long distances which lowers the quantity of electricity lost through power lines. Local generation also stabilizes voltages and reduces vulnerability to extreme weather and terrorism.

In terms of the cost, the up front costs for building local plants are greater than for central generation, however connecting to a grid requires payments for generation and distribution. Denmark pushes for local generation, and with 52 percent of their power

generated locally, they are approaching 60 percent efficiency. Other countries that have already implemented combined heat and power, at around 20 percent of their total electric generation, include Portugal, China, Japan, Poland and Germany. In order to encourage implementation of combined heat and power and energy recycling, distribution utilities should be required to interconnect those who qualify as clean technology and include the costs in their base rate, as they provide a public benefit. Regulation should also be changed to address utility bias towards central generation. And finally, there should be incentives for industries to recycle energy, as there are risks involved in the initial phases of implementation. About half of the states in the U.S. have eliminated these barriers, and some states, such as Connecticut, New York, and California are moving towards eliminating standby and interconnection charges. *(Pertains to Section 5(1) d and g of the Authorizing Legislation)*

Raymond DuBosè, the Director of the Energy Services Department at the University of North Carolina at Chapel Hill gave a presentation on the award-winning energy facilities located on the University campus. The campus facility is composed of a combined heat and power facility (CHP) which simultaneously generates steam and electricity and distributes thermal and electrical energy throughout the system – a central chilled water system – and central plants and underground systems for the production and distribution of steam. These campus facilities generate a third of the power used on campus, and the remaining two thirds are purchased from Duke Energy. The thermal efficiency of the UNC Chapel Hill CHP facility – 70 percent – is twice that of the average U.S. power plant. Some of the innovations of the facility include: using the steam to run a turbine and a generator which meets a third of the peak campus demand; the high pressure steam from the boilers is used for the heating and cooling of all buildings on campus and the hot water in residence halls, the hospital and research labs; use circulating fluid out of bed combustion (CFB) to burn coal which reduces the release of nitrous oxides and sulfur dioxide; and central chilled water plants, cooled at night when energy prices are low, which use steam to generate chilled water for all campus air conditioning needs. *(Pertains to Section 5(1) g of the Authorizing Legislation)*

Reverend Michael Cogsdale, the President of the North Carolina Council of Churches and the Rector of Saint James Episcopal Church in Lenoir, presented some perspectives on global climate change from the faith community of North Carolina. The North Carolina Council of Churches represents 25 denominational bodies and 1.5 million people of faith in the State. There has been a movement among the mainline denominations in the past twenty years to develop a new appreciation for the natural environment and a renewed understanding of the sacred writings which call for a commitment to the stewardship of creation. Because the threat of climate change is global and will likely impact the poor and vulnerable the most, it touches on a spiritual problem for communities of faith, in that they must work for the common good of all people. Also, congregations see the care of creation as a religious duty and are looking for ways to respond and channel their desire to care for creation into actions. In North Carolina, the faith community is responding to climate change by promoting renewable energy, energy efficiency, and conservation through their affiliation with the Interfaith Power and Light Campaign, by increasing educational opportunities to understand the relationship

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between love for God and care for Creation, by forming interfaith coalitions on climate change issues, by conducting energy audits, and reducing energy use. In closing, Rev. Cogsdale stated that the constituents of the North Carolina Council of Churches are also those of the General Assembly, and that these same people care about the earth beyond the price of gasoline. As a representative of this large organization, Rev. Cogsdale requested that the Commission's recommendations be significant and based on the long-term appraisal of nature's laws and not only the short-term economic gain.
(Pertains to Section 5(1) e and f of the Authorizing Legislation)

The meeting was adjourned by Representative Hackney at 1:40pm.

JANUARY 12, 2007

The Legislative Commission on Global Climate Change convened on Friday January 12, 2006 at 10:00 a.m. in Room 643 of the Legislative Office Building.

Mr. John Garrou, Co-Chair, presided over the meeting. George Givens, Commission Counsel, reviewed the agenda items for the day's meeting. Mr. Garrou noted that there will be a five-part presentation on the effects of global climate change as they relate to coastal adaptation, a report on the study of a renewable energy portfolio standard done by the Utilities Commission, and a report from the Climate Action Plan Advisory Group (CAPAG) regarding how they are going to proceed for the rest of the present series of meetings and how they are going to create a report.

S. Jeffress Williams, a Coastal Marine Geologist with the U.S. Geological Survey (USGS) /Woods Hole Science Center, Woods Hole, Massachusetts, presented on the coastal vulnerability to erosion, storm hazards, and potential future sea-level rise. Mr. Williams pointed out that a lot of highly credible scientific information exists about what is happening at the coast and what is likely to happen. Mr. Williams discussed changes in coastal processes including the North Carolina shoreline changes which are undergoing long term erosion and hurricane seasons, with 2005 being a record hurricane season. Mr. Williams discussed historic trends in sea level, global sea level rise, and sea level rise in North Carolina, including future projections. He highlighted climate change and coastal issues projects that the USGS has worked on or is working on including a quantitative assessment of coastal water vulnerability and the development of a numerical model to understand the evolution and future potential of sea level rise. Mr. Williams summarized several important points for the Commission: (1) sea level is rising and is a primary driver of coastal change and future rates of coastal erosion and inundation will increase; (2) climate change is warming the oceans and sea level rise is accelerating due to thermal expansion and increased melting. (The future sea level rise is likely to be on the order of 18 inches higher by the year 2100 and melting on Greenland and Antarctica could further accelerate this rate.); (3) despite the natural cycle of hurricane activity, warming ocean temperatures seem to be increasing the hurricane intensity; and (4) science should guide coastal management and policy adaptation to climate change.
(Pertains to Section 5(1) a and e of the Authorizing Legislation)

Debra Hernandez, President of Hernandez and Company gave a summary of the National Academy of Sciences (NAS) report *Mitigating Shore Erosion along Sheltered Coasts*. The purpose of this report was to examine the impacts of shoreline management on sheltered coastal environments and identify conventional and alternative strategies to minimize potential negative impacts to adjacent or nearby coastal resources. The study provides a framework for collaboration between different levels of owners to aid in making decisions regarding the most appropriate alternatives for shoreline protection. It provides information on the engineering approaches and land management/planning measures that are available to protect sheltered coastlines from erosion or inundation and points out the information needed to determine where and when these measures are reliable and effective, both from an engineering and a habitat perspective. It addresses likely impacts of various shoreline protection practices and discusses how design criteria, technologies, and land use plans can be implemented to protect the environment and property over the long-term. Ms. Hernandez asserted that decision makers, including landowners, contractors, and state and federal authorities, are generally unaware of alternative erosion mitigation strategies and their effectiveness. She concluded by recommending that permitting systems be changed so that they can promote mitigation alternatives that are more protective of the ecosystem and the natural resources in the area.
(Pertains to Section 5(1) b and e of the Authorizing Legislation)

Douglas Rader, Principal Scientist for Oceans and Estuaries with Environmental Defense, discussed specific implications of climate change for North Carolina's coastline. Mr. Rader discussed impacts to the Albemarle and Pamlico Sounds, in addition to impacts on organisms in North Carolina's waters and soils, such as the gray trigger fish, stripped bass, shads, migratory birds, and herrings. He also addressed what has happened and what is likely to happen to coral reefs globally and touched on the likelihood that the ocean's biogeochemical capacity to produce calcium carbonate will decrease. He asserted that in North Carolina processes that maintain the coast have been massively altered including water balances on land and the nitrogen and carbon budgets. He pointed out the huge financial opportunity in North Carolina to invest in stock for currently sequestered carbon and peat. Mr. Rader said that a warming world also means changing temperature patterns, altered forest, altered crop potential, altered natural vegetative communities, and altered fisheries. He concluded with numerous policy recommendations.
(Pertains to Section 5(1) d, e and g of the Authorizing Legislation)

Courtney Hackney, Chair of the Coastal Resources Commission, and Walter Clark, the Coastal Community and Policy Specialist for North Carolina Sea Grant spoke next. Mr. Hackney discussed North Carolina policies that are in place with regard to coastal erosion and beach nourishment. He also touched on infrastructure, land use plans, basin sediment management, and cumulative impacts, all with regard to North Carolina coastal management. Mr. Hackney pointed out that the insurance industry has brought awareness of sea level rise and coastal form. Mr. Clark discussed public awareness and the importance of hazard notification to owners of beach property.
(Pertains to Section 5(1) e, f, and g of the Authorizing Legislation)

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James Kerr, Commissioner of North Carolina Utilities Commission (NCUC) and Sam Watson, Staff Attorney at the NCUC Report on the study by the North Carolina Utilities Commission of a Renewable Energy Portfolio Standard (REPS) for the State of North Carolina and related issues. Commissioner Kerr described that the NCUC was asked by the Environmental Review Commission if they could oversee a study on renewable energy portfolio standards, including the potential costs and benefits of various renewable portfolio standards scenarios. Sam Watson pointed out that the NCUC tried to provide an objective view of the issues related to potential REPS in North Carolina and then described key findings about the particular emissions scenarios that the study commission explored, including a five and ten percent renewable energy portfolio standard. The audience asked numerous specific questions concerning the REPS study and report.
(Pertains to Section 5(1) e, f and g of the Authorizing Legislation)

Brock Nicholson, Deputy Director of the Division of Air Quality (DAQ) in the Department of Environment and Natural Resources and Tom Peterson, Executive Director of the Center for Climate Strategies presented the current progress of the Carolina Climate Action Plan Advisory Group (CAPAG) process. Mr. Nicholson and Mr. Peterson reviewed the draft CAPAG mitigation options and the summary list of draft options. They pointed out that CAPAG had started with 300 draft potential mitigation options and had narrowed it down to 52 by considering the most promising options. Mr. Peterson asserted that all 52 would be reviewed at CAPAG's next meeting in which they will identify those options that do not have any objections. They expect extensive discussion and possibly modifications on some of the options. Mr. Peterson summarized the list of recommendations of CAPAG and explained the tables that were contained in the handout. Mr. Nicholson and Mr. Peterson's presentation was followed by numerous questions and discussion among the Commission with regard to the information they presented.
(Pertains to Section 5(1) d, e, f and g of the Authorizing Legislation)

The meeting was adjourned at 3:30 p.m. by Co-chair John Garrou.

February 22, 2007

At the February 22, 2007, meeting of the Legislative Commission on Global Climate Change (LCGCC or Commission), the LCGCC adopted by voice vote the following 17 proposals for inclusion as recommendations in the Commission's Interim Report. The mitigation options recommended for adoption by the LCGCC include the actions beginning on the next page.

COMMISSION RECOMMENDATIONS

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Commission Recommendation 1
Option: *Expand Energy Efficiency Funds.*
Source: Residential Commercial and Industrial Mitigation Option 2 (RCI-2).

Commission Recommendation 2
Option: *Energy Efficiency Requirements for Government Buildings.*
Source: Residential Commercial and Industrial Mitigation Option 3 (RCI-3), with inclusion of one of the following two language additions (recommended by Commission member Mr. Slocum):

"Adherence to energy related guidelines in LEED+ or Green Globes standards."

or

"For the purposes of determining LEED certification, credit may be awarded for the use of wood-based materials derived from all credible sources, including the Sustainable Forestry Initiative Program, the Canadian Standards Association, the American Tree Farm System and other credible certified sources programs."

Commission Recommendation 3
Option: *Market Transformation and Technology Development Programs.*
Source: Residential Commercial and Industrial Mitigation Option 4 (RCI-4).

Commission Recommendation 4
Option: *Improved Appliance and Equipment Efficiency Standards.*
Source: Residential Commercial and Industrial Mitigation Option 5 (RCI-5).

Commission Recommendation 5
Option: *Building Energy Codes.*
Source: Residential Commercial and Industrial Mitigation Option 6 (RCI-6).

Commission Recommendation 6
Option: *"Beyond Code" Building Design Incentives and Targets, Incorporating Local Building Materials and Advanced Construction.*
Source: Residential Commercial and Industrial Mitigation Option 7 (RCI-7).

Commission Recommendation 7
Option: *Education (Consumer, Primary/Secondary, Post-Secondary/Specialist, College and University Programs).*
Source: Residential Commercial and Industrial Mitigation Option 8 (RCI-8).

Commission Recommendation 8
Option: *Residential, Commercial, and Industrial Energy and Emissions Technical Assistance and Recommended Measure Implementation.*
Source: Residential Commercial and Industrial Mitigation Option 11 (RCI-11).

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Commission Recommendation 9

Option: *Removing Barriers and Providing Incentives to Combined Heat and Power (CHP) and Clean Distributed Generation (DG).*

Source: Energy Supply Mitigation Options 3 and 9 (ES-3 and ES-9).

Note: Commission Counsel will send a letter to the North Carolina Utilities Commission (NCUC) on behalf of the LCGCC to request that the NCUC study issues related to interconnection that are barriers to the development of CHP systems. In particular, the LCGCC will request that the NCUC open a docket for the purpose of establishing an interconnection standard for the power interval between 100 kilowatts and the FERC standard 2 megawatts.

Commission Recommendation 10

Option: *Greenhouse Gas Inventories and Forecasts (I&F), State Greenhouse Gas Reporting, and State Greenhouse Gas Registry.*

Source: Cross Cutting Issues Mitigation Options 1, 2, and 3 (CC-1, CC-2, and CC-3), with inclusion of "possible consequences" in Mitigation Option CC-1 (recommended by Dr. Riggs).

Commission Recommendation 11

Option: *State Climate Public Education and Outreach.*

Source: Cross Cutting Issues Mitigation Option 4 (CC-4).

Commission Recommendation 12

Option: *State Climate Change Adaptation Strategy.*

Source: Cross Cutting Issues Mitigation Option 5 (CC-5), with the inclusion of the following three additions:

- Include the State Hazard Mitigation Planning Group (recommended by Commission member Dr. Boyles).
- Address major storm/critical events (recommended by Commission member Dr. Riggs).
- Address coastal hazards disclosure (recommended by Commission member Rep. Harrison).

Commission Recommendation 13

Option: *Options for State Greenhouse Gas Goals or Targets.*

Source: Cross Cutting Issues Mitigation Option 6 (CC-6).

Note: When the Commission resumes meeting after the 2007 Session of the General Assembly adjourns, the Commission will establish a State greenhouse gas emissions goal.

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Commission Recommendation 14

Option: *Renewable Energy Portfolio Standard (REPS).*

Source: NC Commission Member Additional Option 1.

Note: The Commission endorses the concept of a Renewable Energy Portfolio Standard (REPS) (similar to that described in ES-2) without setting a specific target percentage (recommended by Commission members Mr. Toben; and Mr. Shore, Mr. Smith, Mr. Stephenson, and Mr. Urlaub).

Commission Recommendation 15

Option: *Management of Hog Manure.*

Source: NC Commission Member Additional Option 8.

Notes:

- The Commission recommends the *Management of Hog Manure* proposal with a modification that subsidies be provided for lagoon conversion to achieve greenhouse gas reductions.
- Commission member Mr. Profeta offered the proposal; Commission member Dr. Riggs moved for the modification. Mr. Profeta provided draft legislation on this proposal.

Commission Recommendation 16

Option: *Change Net Metering Regulations.*

Source: NC Commission Member Additional Option No. 21.

Notes:

- The Commission recommends that legislation be enacted to c*hange net metering regulations to allow more use.*
- Commission member Dr. Eggers offered the proposal. Dr. Eggers provided draft legislation on this proposal.

Commission Recommendation 17

Option: *Transport Statement.*

Source: By motion of Commission member Mr. Smith.

Note: The following statement will be included in the report: "The Commission acknowledges that substantial greenhouse gas reductions can be achieved in the transportation sector. The Commission will continue to study ways to achieve these reductions."

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The following is a summary table of suggested options by Commission members:

Table 1. NC Commission Member Additional Options

Suggestion #	GHG Mitigation Action	Notes	Recommended By
1.	Renewable Portfolio Standard combined with Energy Efficiency Standards amounting to a 20% Energy Supply and Offset Mix (REPS) by the year 2020.	Under consideration by the CAPAG, and will require some additional analysis. This is generally consistent with RCI-1 and RCI-2, though we will need to consider the need for aligning the goals of ES-2 with RCI options (which we would have had to do anyway). Linked to several AFW options covering animal waste to methane energy, landfill gas to energy, agricultural waste to energy, forestry biomass to energy. Note linkage to feedstock supplies for this option coming out of AFW-5, 9, 10 and 11.	Toben; Shore, Smith, Stephenson, and Urlaub (Shore et al.)
8.	Expand the NC Green Power program to include all available sources and not just a very limited subset of forest biomass.	Under consideration by the CAPAG under RCI-9 and covered under AFW-9&10. Note: Separated this option from option 7 after LCGCC meeting on March 22, 2007.	Slocum
21.	Draft bill to change NC net metering regulations to allow more use and streamline regulations.	Covered and included, in a more general way than the bill, in the mitigation option design and implementation measures in RCI-10.	Eggers



ECU - News Bureau

Coastal hazards web site developed by ECU experts

GREENVILLE, N.C. (Oct. 6, 2008) — A new website developed by coastal experts at East Carolina University provides a high-tech, one-stop site for information about hurricanes, storm surges and their potential effects on the North Carolina coast.

The web site, North Carolina COastal HAZards Decision Portal (NC COHAZ), presents in a user-friendly way the latest research from members of ECU's Institute for Coastal Science and Policy and the departments of Geological Sciences and Geography, and links to work from scientists across the state. The address for the site is http://www.coastal.geology.ecu.edu/NCCOHAZ/.

"The coast of North Carolina is at risk to a diversity of hazards, and these hazards can have major consequences for people who live, work, and recreate in areas along the coast," said J.P. Walsh, a professor of geology at ECU. "There has been much research conducted on coastal hazards affecting North Carolina and their consequences, but information is scattered far and wide and is often hard to track down."

Several mapping tools, that overlay satellite images of the Outer Banks with areas that are at-risk for flooding and erosion, are also available. Walsh said the maps would enable researchers, emergency managers and the public to view the areas along the coast most at-risk of suffering these hazards.

"We believe it is beneficial to have this information out and accessible where it can be considered and explored," Walsh said.

Walsh and geology colleague Reide Corbett have teamed up with ECU geographers Tom Allen, Tom Crawford and Stephen Sanchagrin to develop the site. Support for the NC COHAZ site has been provided by grants from the State and the RENaissance Computing Institute (RENCI). The researchers are focused on a diversity of topics ranging from shoreline erosion to storm surge visualization to economic effects of hazards.

"We hope this site will improve communication and information exchange around the state," Walsh said. "Ultimately, we are building this site to help minimize the impacts of coastal hazards on the citizens of North Carolina, and this can only be accomplished through improved sharing of knowledge, data and ideas."

Visit: http://www.coastal.geology.ecu.edu/NCCOHAZ/ to view the site.

NORTH CAROLINA'S COASTS IN CRISIS: A VISION FOR THE FUTURE

A White Paper by

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David J. Mallinson, D. Reide Corbett[1], and J.P. Walsh[1]

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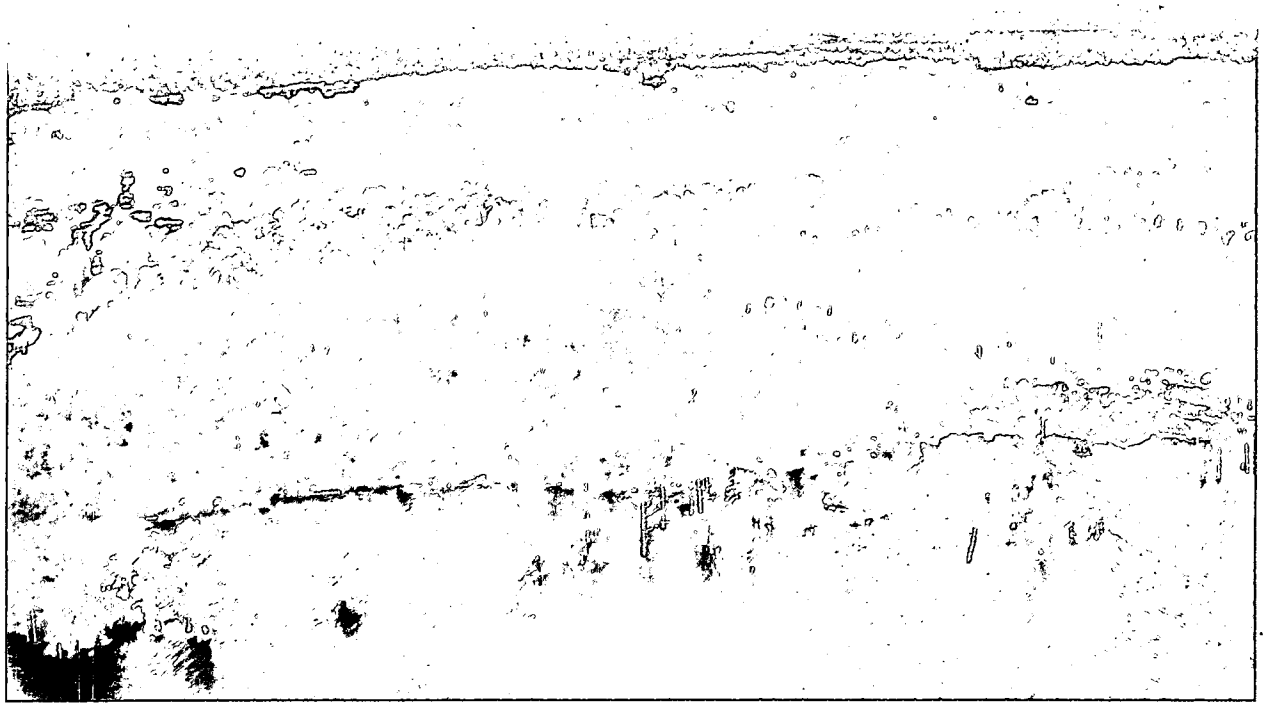
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October 2008

Shoreline change in the Albemarle-Pamlico Estuarine System, North Carolina



A drowning forest in the Neuse River Estuary

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Draft of a report to be published by East Carolina University

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EXECUTIVE SUMMARY

Coastlines are constantly changing due to both natural and anthropogenic forces. On-going climate change and associated sea-level rise are reshaping our coasts. However, the oceanfront is no longer the only concern. Shoreline dynamics along more sheltered estuaries, like those found in the Albemarle-Pamlico Sound (APES), have gained attention. We need to better understand and manage these critical boundary resources. Research conducted on the Neuse River Estuary demonstrates the dominance of erosion along the shore of our estuaries, regardless of shore-type (e.g., marsh, beach, bluff). Erosion rates greater than 10 feet per year over a 40 year period were measured using aerial photography from 1958 and 1998. An average erosion rate of ~1 foot per year was calculated for the entire Neuse River Estuary. These erosion rates have led property owners to try stopping the loss of their water front property by means of shoreline stabilization structures (i.e., riprap, sills, seawalls, etc.). About 30% of the shoreline along the Neuse River Estuary has been modified with these stabilization structures with little understanding of the short-term ecological impacts or the long-term impacts associated with ongoing climate change and sea-level rise. It is imperative that we better understand the potential changes coastal North Carolina faces in the near future.

INTRODUCTION

Affected by a diversity of natural and anthropogenic processes, coastal areas are dynamic systems that are heavily populated. Excluding Alaska, coastal counties comprise 17% of the nation's land, yet they contain over 50% of the United States population (based on 2003 census data, Crossett et al. 2004). Crossett et al. (2004) determined that the national average population density (excluding Alaska) is 98 people per square mile for non-coastal counties, as compared to 300 persons per square mile for coastal counties. Consequently, the development and management of coastal areas is of great concern, especially in light of our demonstrably changing climate.

Sea-level change is an important consequence of climate change, both for society and the environment. Estimates of global sea-level rise (SLR) for the 21st century ranges from 0.3 to 2.9 feet, but local increases in relative sea level may be much higher or lower due to factors such as subsidence, sediment compaction, or uplift (IPCC, 2007). Many coastal areas will experience increased levels of flooding, accelerated erosion, loss of wetlands and low-lying terrestrial ecosystems, and seawater intrusion into freshwater sources as a result of SLR and potentially enhanced storm frequency and severity. Prediction of shoreline retreat and land loss rates is critical for planning of future coastal zone management

Key Concepts

Shoreline: the physical interface between land, air, and water.
Shorezone: the land area that extends from an estuarine shoreline landward to where the hydrologic influence of sea level diminishes and terrestrial hydrology dominates.
Ecosystem goods and services: the end products of natural ecosystems that yield human well-being and value (e.g. fish from the sea, beauty of the coast). Conditions that define an ecosystem service include: (1) the service emerges from the natural environment; (2) the service enhances human well-being; and (3) the service is an end product of nature directly used by people.

strategies, and to assess biological impacts due to habitat changes and loss (Thieler and Hammer-Klose, 1999).



Figure 1. Images of shoreline recession in the modern northeastern North Carolina estuarine coastal system as a result of storm processes and ongoing sea-level rise.

The Albemarle-Pamlico Estuarine System (APES) of North Carolina is the second largest estuary in the United States and contains an extensive estuarine marshes that provide critical habitat for a variety of ecosystem goods and services. Based on tide gauge measurements analyzed by the National Ocean and Atmospheric Administration (NOAA, 2004), the measured rate of relative SLR in North Carolina ranges from 0.07 to 0.17 inches per year with rates increasing from south to north. The rise in sea level over the last several decades already has had major impacts on North Carolina's mainland estuarine coastlines (**Figure 1**). Rates of shoreline recession are a function of shoreline type, geometry and composition, geographic location, size and shape of the associated coastal water body, coastal vegetation, water level, and storm frequency and intensity, all of which vary dramatically alongshore (Riggs and Ames, 2003). With SLR and shoreline recession, the function of any shorezone may be significantly altered by the transformation from one ecosystem class to another (e.g., from wetlands to open water) (Brinson et al., 1995).

Ultimately, to manage our coastal estuarine resources wisely and to maximize human utilization, long-term solutions of estuarine shoreline erosion problems must be in harmony with the dynamics of the entire coastal shoreline and shorezone system. This document summarizes the results of a multi-year, multidisciplinary study funded by NOAA and designed to address this need. The overall goal of the project was to evaluate mainland shoreline and shore-zone compositional changes over four decades (1958-1998) within the Neuse River Estuary, a major component of the APES (**Figure 2**).

NORTH CAROLINA'S ESTUARINE SHORELINE

Due to the low topographic slopes on the coastal plain (less than 0.3 feet elevation for every horizontal mile), the majority of the coastal zone in northeastern North Carolina is within a few feet of current sea level. As a result, shoreline recession has consumed approximately 50 square miles of coastal lands over the past 25 years, more than half of which are critical wetland environments (Riggs and Ames, 2003). We cannot stop this natural process of estuarine shoreline recession in North Carolina. However, better knowledge of the consequences of SLR and associated shoreline recession would be economically, socially, and environmentally advantageous. Below we summarize factors critical to understanding the

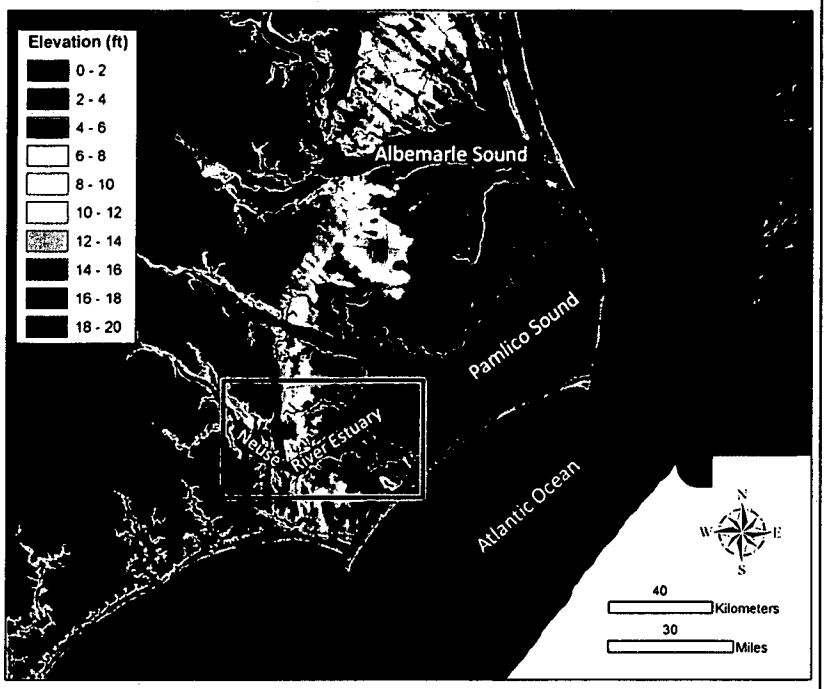


Figure 2. Elevation map of coastal NC showing the Albemarle-Pamlico estuarine system (APES). Note that much of the region is extremely low lying (less than 2ft above sea level) and extremely susceptible to modification by storms and ongoing sea-level rise. The closed triangle and circle denote Point Peter Road and Bay Hills, respectively.



Figure 3. Photographs show four different types of shorezones within the Albemarle-Pamlico estuarine system (APES) (Riggs and Ames, 2003) and the following: A) high sediment bank; B) low sediment bank being converted to a freshwater marsh; C) platform marsh shoreline retreating into a swamp forest; and D) pocosin swamp forest receding shoreline common in fresh water portions of the APES region.

dynamics of the estuarine shorezone along the APES and ecological state change in northeastern North Carolina estuaries.

Previous Work on Estuarine Shoreline Change

North Carolina's coastal zone, sounds and estuaries are a product of post-glacial SLR and flooding up the stream valleys of the drainage systems (**Figure 2**). Shorezones have been geomorphologically classified into four basic categories: sediment bank, organic, combination, and back-barrier shorelines (**Figure 3**; **Table 1**; Riggs and Ames, 2003). Sediment bank shorezones tend to be steeply sloping, and often have a wave-cut scarp. Sand that forms the beach is derived from erosion of the adjacent sediment bank (**Figure 3 A, B**). Organic shorezones consist of water-tolerant flora, including grasses (e.g., smooth cordgrass and salt meadow cordgrass: *Spartina alterniflora* and *Spartina patens*), rushes (e.g., black needlerush: *Juncus roemerianus*), shrubs (e.g., marsh elder: *Iva frutescens*) that grow at the land/water interface and are capable of withstanding extended periods of flooding by water with variable salinities. In freshwater

areas, trees (e.g., bald cypress and water tupulo: *Taxodium distichum*and *Nyssa aquatica*) form vast swamp forest wetlands. Estuarine marsh shorezones occur throughout most of the estuarine system (**Figure 3 C**), but swamp forest shorezones are restricted to the freshwater areas (**Figure 3 D**). Combination shorezones are those of diverse composition (including human modification) and are present throughout the NC coastal system.

Table 1. Shoreline categories in the Albemarle-Pamlico Estuarine System and their defining parameters (from Riggs and Ames, 2003).

Shoreline Categories	Shoreline Sub-type	Defining Parameters
Sediment Bank Shorelines	Bluff	Greater than 20 feet
	High bank	5-20 feet
	Low bank	Less than 5 feet
Organic Shorelines	Swamp forest	Freshwater riverine floodplains and freshwater pocosins
	Marsh	Fresh, brackish, and salt waters
Combination Shorelines	Sediment bank with cypress fringe	
	Sediment bank with marsh fringe	
	Sediment bank with Fringe of log and shrub debris	
	Low sediment bank with stumps	
	Swamp forest with strandplain beach	
	Marsh with strandplain beach	
	Human-modified shoreline	
Back-Barrier Shorelines	Overwash barriers	Sand fans and platform marshes
	Complex barriers	Sediment banks and organic banks
	Inlet	Flood-tide deltas

Most estuarine shorelines in North Carolina are eroding in response to the interaction of storms and ongoing sea-level rise. However, previous studies indicate that shoreline erosion is extremely variable from site to site with significant ranges in erosion rates evident over short distances (Riggs, 2001; Riggs and Ames, 2003). The Riggs and Ames (2003) site with the highest average rate of recession was the platform marsh at Point Peter Road (Pamlico Sound; see Figure 2 for site location) with an average recession rate of -7.5 feet per year in contrast to the lowest average recession rate of less than -1 foot per year along the bluff shoreline at Bay Hills (head of Pamlico River; see Figure 2 for site location). Shoreline change rates varied from 0 feet per year during periods of low storm activity to a high of -26 feet per year (erosion) along the sand bluffs at the north end of Roanoke Island during periods of high storm activity. Riggs and Ames (2003) determined that the average annual estuarine shoreline change rates for specific shoreline types ranged between +0.6 feet per year (accretion) for back barrier beaches to -3.3 feet per year (erosion) for the mainland marshes.

Several important patterns concerning average annual shoreline erosion rates for major shoreline types and estuarine regions are obvious from these data. Mainland marsh and low sediment bank have the overall highest average rates of estuarine shoreline recession (-3.3 feet per year). They are also the most abundant shoreline types, constituting about 85% of the coastal system in northeastern North Carolina. Bluffs and high sediment banks, with their available sand, debris and vegetation, are less abundant (about 8%) and generally erode more slowly (-2.6 feet per year) compared to low sediment banks. Swamp forest shorelines are the least abundant (about 7%) and erode the slowest (-2.3 feet per year) due to their lack of elevation and low offshore gradients together with the role of trees in abating wave energy. Based upon these local studies, research has identified that several physical variables act to shape/modify the shoreline as sea level rises, producing the alongshore variability in erosion rates (**Table 2**). The research presented below builds on this significant body of previous work.

Table 2. Physical variables shaping estuarine shorelines (modified from Riggs and Ames, 2003).

Shoreline Variables	Definition	Potential for Erosion	
		Low	High
Fetch	Average distance of open water in front of shoreline	Short Fetch (<1000 feet)	Long Fetch (>1000 feet)
Offshore bottom character	Water depth and bottom slope in the nearshore area	Shallow, gradual slope (<3 feet)	Deep, steep slope (>3 feet)
Geometry of shoreline	Shape and regularity of shoreline (sinuosity)	Highly irregular or in a cove	Straight or on a headleand
Height of sediment bank	Bank height at shoreline or immediately behind sand beach	High (>6 feet)	Low (<6 feet)
Composition of sediment bank	Composition and degree of cementation of bank sediments	Rock, tight clay	Uncemented sand, peat
Fringing vegetation	Type and abundance of vegetation (aquatic plants, marsh grasses, shrubs, trees, etc.) occurring in front of sediment bank	Very abundant, dense	Absent
Boat wakes	Proximity of property to, frequency and type of boat channel use	Absence of boats	Marinas, intracoastal waterway
Storms	Storms are the single most important factor determining specific erosional events	Type, intensity, duration and frequency of storms	

ANALYZING SHORELINE CHANGE

Shoreline change can be calculated through the time-series comparison of various data sets that include ground surveys, aerial photography, satellite imagery, synthetic aperture radar, light detecting and ranging (LIDAR), and global positioning system. Although new satellite and other remotely sensed approaches are becoming feasible (e.g., LIDAR, see Li et al. 2001), aerial photography analysis remains the most commonly used method to calculate shoreline change (Boak and Turner 2005).

Spatial and temporal errors are potentially created when using aerial photography to calculate shoreline change. Spatial distortion includes tilt, radial distortion, and relief displacement. However, these distortions are generally corrected when the image is rectified. Rectification gives the image a spatial reference and is necessary before shoreline demarcation. Since aerial photograph is a snapshot in time of a dynamic system that producing a temporal shoreline error that can represent either large-scale, short-term changes in immediate response to storms or smaller net changes that average out the larger events over the long-term. It is essential to document and understand both the storm dominated shoreline processes and the shoreline change over decadal timescales that define the net long-term changes.

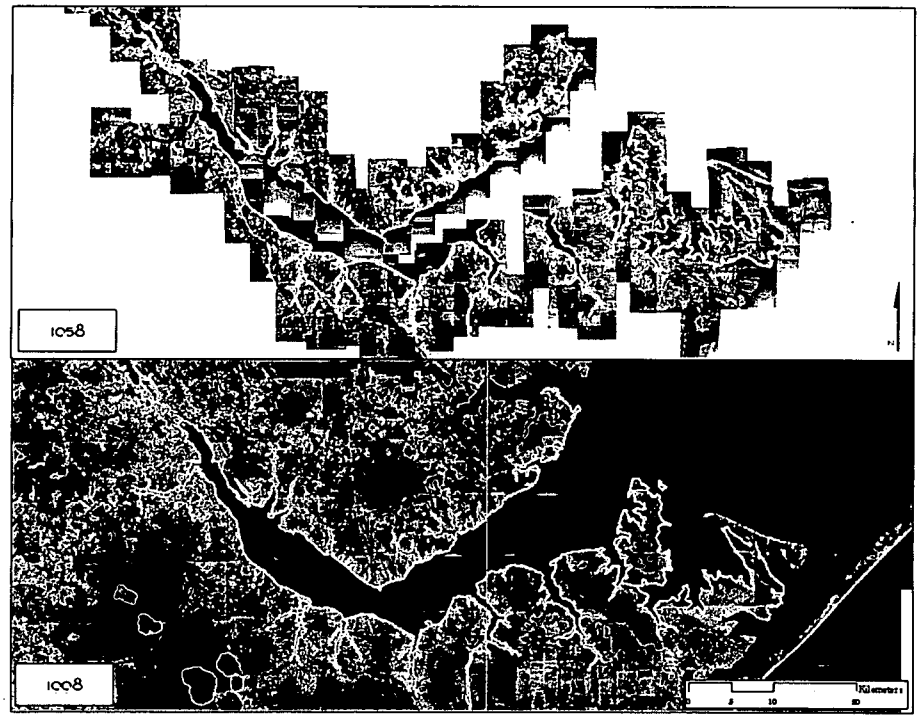


Figure 4. Representation of the areas that have been georectified and the associated digitized shorelines for the 1958 and 1998 aerial photographs of the Neuse River Estuary.

Evaluating changes in shoreline position using aerial photographs can be quite challenging and time-consuming. In summary, we used spatially-referenced aerial photographs of the Neuse River Estuary from 1958 and 1998 time periods,. The shoreline was digitally traced (outlined) using ESRI GIS and mapping software, ArcGIS®. Once the entire shoreline was digitized for the two different time periods (**Figure 4**), the difference in shoreline position was measured at 150-foot spacing along the entire shoreline for the 40 year period to determine the amount of either erosion or accretion.

SHORELINE CHANGE IN THE NEUSE RIVER ESTUARY

Over 40 years (1958-1998), the vast majority (93%) of the Neuse River Estuary shoreline eroded (the shoreline moved landward). Only a small fraction (6.6%) of the shoreline accreted (the shoreline moved seaward), and less than 1% did not change (**Figure 5**). The rate of shoreline change varied widely from -11.5 feet per year (erosion) to +9.5 feet per year (accretion). The average shoreline change rate for the entire study area, including the tributaries, over the 40 year period was approximately -1 foot per year (erosion).

The rate of shoreline retreat is influenced by many factors, including but not limited to wave energy and duration, fetch of water that generates these waves, and boat wakes (**Table 2**). The influence of fetch, and therefore the resultant wave energy, can easily be seen in the erosion rates observed in the Neuse River Estuary. For example, some of the lowest erosion rates are found in the small tributaries and in head water portions of the estuary (symbols are mostly yellows and greens, **Figure 5**). In contrast, those areas along the main trunk of the estuary exposed to a fetch that included Pamlico Sound, had the greatest rates of erosion (**Figure 5**). This higher erosion rate along much of the Neuse River trunk is associated with the relentless wave attack during windy days and strong storms (e.g., hurricanes and nor'easters). With rising sea level and possible enhanced storm activity, it is highly probable that estuarine shoreline recession will become more severe in the near future.

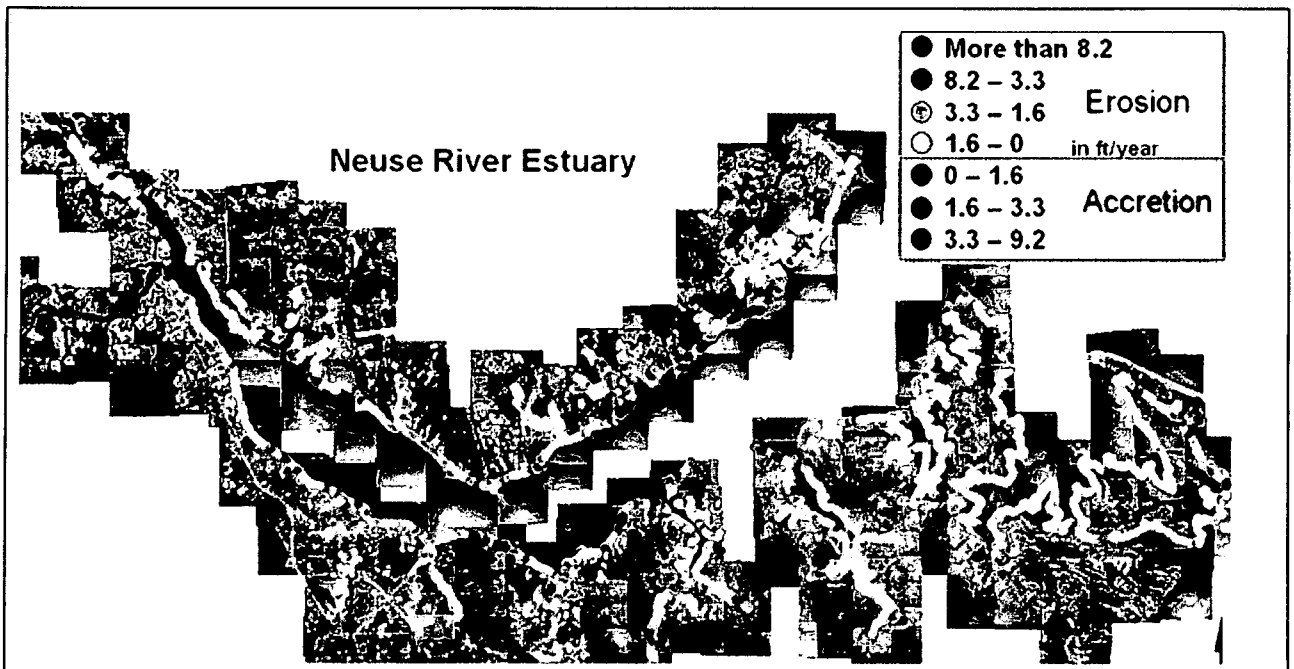


Figure 5. Map of shoreline change rate between 1958 and 1998 (40 years) along the Neuse River Estuary. Areas with higher erosion rates are denoted by colors of yellow to pink, while areas that have accreted are represented by green to purple.

SHORELINE STABILIZATION

Shorelines within APES are dynamic features that are receding significantly along most of the estuarine coast. Managing this coastal land loss is becoming ever more critical as coastal populations increase. The North Carolina Division of Coastal Management recognizes the importance of shoreline erosion management and recently established a working group charged with developing recommendations to guide the development of new estuarine shoreline stabilization rules. This Estuarine Biological and Physical Processes Working Group is providing guidance on the most appropriate stabilization method (**Table 3**) for different shoreline types. The number one recommendation for all estuarine shoreline types was land planning (i.e., leave the shorezone in its natural state). However, today this is not the

method used by most property owners along the trunk of the Neuse River Estuary. Approximately 30% of the mapped shoreline has been modified in an attempt to slow shoreline recession (**Figure 6**).

Table 3. Shoreline stabilization methods outlined in August 2006 by the North Carolina Estuarine Biological and Physical Processes Working Group (http://dcm2.enr.state.nc.us/Hazards/EWG%20Final%20Report%20082106.pdf).

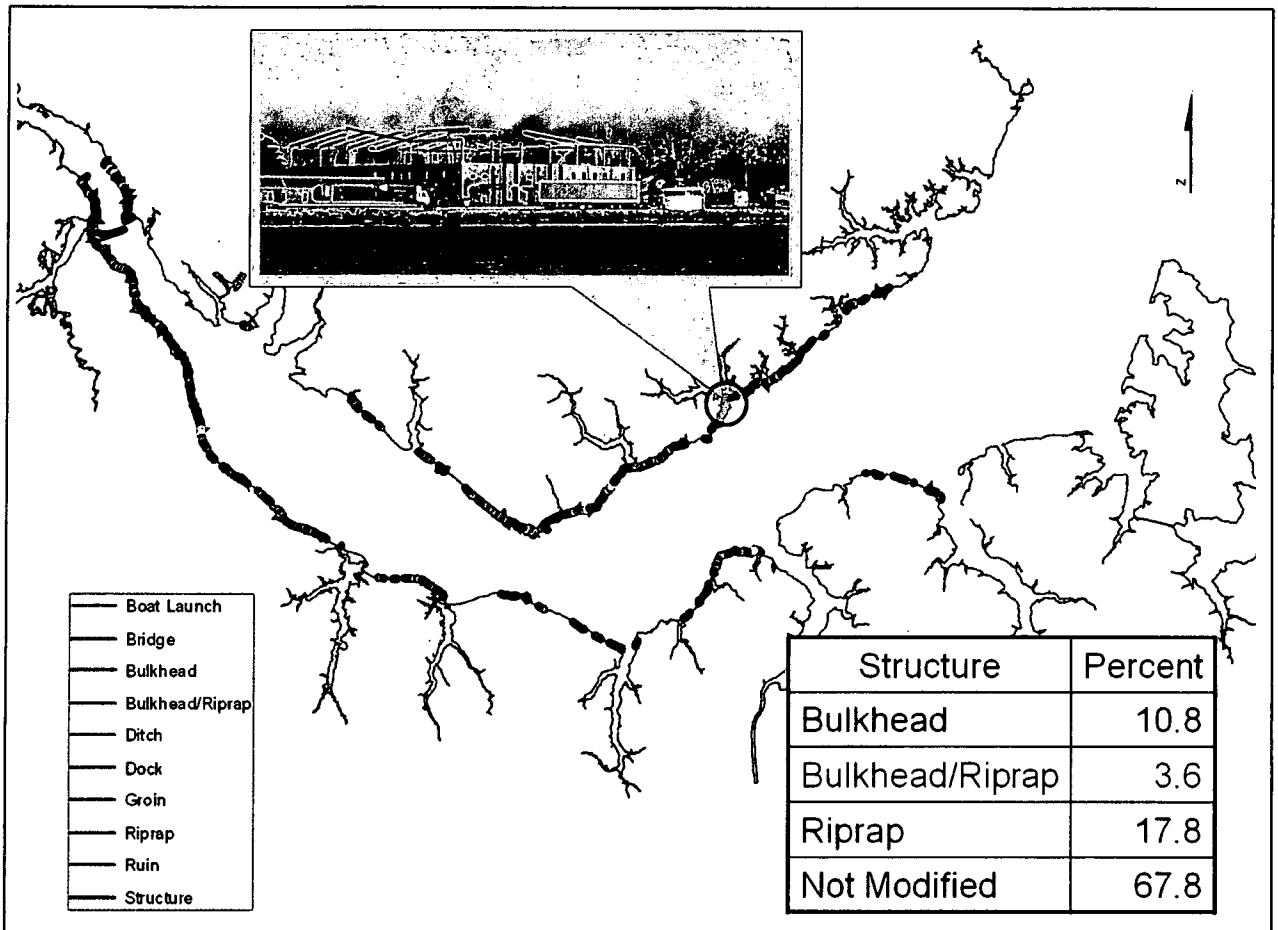
Structure Type	Aliases	Erosion Control Purpose
Land planning		Leave the shorezone in its natural state.
Vegetation control	Wetland or upland plantings	Creates a buffer to dissipate energy.
Beach fill	Beach nourishment	Acts as a sacrificial erosive barrier.
Sills	Marsh sill, wooden breakwater, wave board	Reduces wave energy on the shoreline. Traps sediment landward to rebuild/protect wetlands.
Groins	Jetties	Trap sand on the updrift side to build out the upland.
Breakwaters	Wave attenuator	Reduces wave energy on the shoreline. Traps sediment between the shore and breakwater.
Sloped structures	Riprap, revetment, sloped seawall	Protect land from erosion and absorb wave energy without reflecting waves.
Vertical structures	Bulkhead, seawall, gravity wall	Hold back the land.

First, it must be understood that not all shorelines are at serious risk to significant erosion, as can be seen in **Figure 6**. Second, mitigation measures against shoreline erosion can have significant negative impacts on the immediate and adjacent coastal environments (e.g., neighbors and local fishing areas). Third, installing hardened structures should really be undertaken as a last resort and not as an unnecessary preventative measure or for homeowner convenience.

If mitigation is needed, consult the web site of the Division of Coastal Management (DCM) and communicate with them to be sure that the recommended guidelines and laws are followed: http://dcm2.enr.state.nc.us/Hazards/estuarine.htm.

The following document can be used to understand what structures are recommended for different settings: http://dcm2.enr.state.nc.us/Hazards/EWG%20Final%20Report%20082106.pdf

Examples of various shoreline stabilization methods are presented here: http://dcm2.enr.state.nc.us/Hazards/estuarine_stabilization%20options.htm



Structure	Percent
Bulkhead	10.8
Bulkhead/Riprap	3.6
Riprap	17.8
Not Modified	67.8

Figure 6. Modified shorelines mapped along the trunk of the Neuse River Estuary in December 2007. The inset is an example of a shoreline stabilized with riprap along the Oriental waterfront.

SUMMARY

Erosion of estuarine shorelines is an ongoing and natural process within the northeastern North Carolina coastal system. Erosion rates are extremely variable, but the majority of the estuarine shorelines are currently eroding. This rapid and significant loss of land has led many property owners to use various stabilization methods to combat erosion. Little is known of either the short-term and long-term ecological impacts that these hard structures might have on the system, particularly if the ongoing processes of climate change and sea-level rise continue. To preserve our coastal estuarine resources and maximize human utilization, long-term management solutions to shoreline recession must be in harmony with the dynamics of the coastal system.

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